UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

15-1229

BERNINA INTERNATIONAL AG,

Appellant,

v.

HANDI QUILTER, INC., TACONY CORPORATION,

Appellees.

Appeal from the United States Patent and Trademark Office,
Patent Trial and Appeal Board in IPR2013-00364

OPENING BRIEF OF APPELLANT BERNINA INTERNATIONAL AG

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Bernina International AG

February 9, 2015

CERTIFICATE OF INTEREST

Counsel for Appellant Bernina International AG certifies the following:

1. The full name of every party or *amicus* represented by me is:

   Bernina International AG

2. The name of the real party in interest (if the party named in the caption is not the real party in interest) represented by me is:

   None

3. All parent corporations and any publicly held companies that own 10 percent or more of the stock of the party or *amicus curiae* represented by me are:

   None

4. The names of all law firms and partners or associates that appeared for the party or *amicus* now represented by me in the trial court or agency or are expected to appear in this court are:

   VOLPE AND KOENIG, P.C.
   Anthony S. Volpe
   Ryan W. O'Donnell
   Max S. Morgan

Respectfully submitted,

Dated: February 9, 2015

/s/Anthony S. Volpe
Anthony S. Volpe
VOLPE AND KOENIG, P.C.

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STATEMENT REQUESTING ORAL ARGUMENT

Bernina International AG ("Bernina") requests oral argument.

STATEMENT OF RELATED CASES

No previous appeals have been taken from this case to any appellate court. The Court's decision in this appeal will directly affect *Bernina International AG v. Handi Quilter, Inc.*, Case No. 2:12-cv-07079-JD (E.D. Pa.), *Bernina International AG v. Tacony Corp.*, Case No. 2:13-cv-01787-JD (E.D. Pa.) and *Inter Partes* Review, case no. IPR2014-00270, also involving U.S. Patent No. 6,883,446 ("the '446 Patent").

JURISDICTIONAL STATEMENT

This is an appeal from the final written decision, issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73, of the United States Patent and Trademark Office, Patent Trial and Appeal Board in *Inter Partes* Review Case No. IPR2013-00364. Bernina filed a notice of appeal on November 21, 2014. This Court has jurisdiction pursuant to 35 U.S.C. § 141(c) and 28 U.S.C. § 1295(a)(4)(A).

STATEMENT OF THE ISSUES

1. Whether the Board erred in determining that Patent Owner's evidence was insufficient to establish conception prior to the publication of an October 8, 2002 Unexamined Japanese Published Patent Application No. 2002/292175 to Watabe ("Watabe").

2. Whether the Board erred in determining that Watabe is prior art under 35 U.S.C. § 102(a).

3. Whether the Board erred in determining that claims 1, 2, 5-7, 10, 12, 13, 17-21, 23-29, 31, 33, and 34 of the ‘446 Patent are unpatentable under 35 U.S.C. § 102(a).

4. Whether the Board erred in determining that claims 1, 2, 5-7, and 23-27 of the ‘446 Patent are unpatentable under 35 U.S.C. § 103(a).

STATEMENT OF THE CASE

This is an appeal from the September 25, 2014 Final Written Decision ("the Decision") of the United States Patent and Trademark Office, Patent Trial and Appeal Board ("Board") in the *inter partes* review of the '446 Patent. The Decision held that claims 1, 2, 5-7, 10, 12, 13, 17-21, 23-29, 31, 33, and 34 of the '446 Patent were anticipated by an October 8, 2002 Unexamined Japanese Published Patent Application No. 2002/292175 to Watabe ("Watabe"). The Board determined that Bernina did not establish an earlier date of conception and concluded that Watabe is applicable prior art under 35 U.S.C. § 102(a). The Board also concluded that claims 1, 2, 5-7, and 23-27 of the '446 Patent are unpatentable over Watabe in view of U.S. Patent No. 4,192,241 to Reed ("Reed").

Bernina submits that the Board erred in determining: (1) that the Patent Owner failed to establish conception prior to the publication of Watabe; (2) that Watabe was applicable as prior art; (3) that claims 1, 2, 5-7, 10, 12, 13, 17-21, 23-29, 31, 33, and 34 of the '446 Patent were unpatentable under 35 U.S.C. § 102(a); and, (4) that claims 1, 2, 5-7, and 23-27 of the '446 Patent were unpatentable under 35 U.S.C. § 103(a).

STATEMENT OF FACTS

I. The ‘446 Patent

The ‘446 Patent was filed on Feb. 11, 2004 and claimed priority to U.S. Provisional Application No. 60/447,159 filed 12 Feb. 2003. A0029. The ‘446 Patent has six independent claims, consisting of apparatus claims 1, 10, 21 and 31 and method claims 23 and 28. A0050-A0052.

A. The Problem In The Prior Art As Described In The ‘446 Patent

The Background of the ‘446 Patent provides that “[a] general goal of the quilting process is to produce precise consistent stitches that are closely and uniformly spaced.” A0045, Col. 1, ll. 30-32. This goal was traditionally achieved using hand-quilting techniques. A0045, Col. 1, ll. 33-34. Because hand-quilting is a time and labor-intensive process, many quilters adopt sewing machines to assist in the quilting process and allow them to direct more attention to the creative and artistic aspects of the pastime. A0045, Col. 1, ll. 34-41.

With the assistance of a sewing machine, a quilter may engage in a “free motion” process, allowing “the user to manually move the stacked quilt layers relative to the machine’s needle, either directly or via a quilt frame, to produce desired patterns of stitches.” A0045, Col. 1, ll. 43-48. However, “[t]his process typically requires significant operator skill … to enable the operator to move the quilt stack in synchronism with the needle stroke to form high quality stitch

patterns." A0045, Col. 1, ll. 50-54. "Thus, free motion quilting with a conventional sewing machine requires significant user skill and yet frequently yields imperfect results, particularly when forming curved and intricate stitch patterns." A0045, Col. 1, ll. 54-57.

B. Prior Art Motor Speed and Stitch Control

The '446 Patent states, "motor speed control capability is a common feature of most modern sewing machines." A0049, Col. 9, ll. 8-10. Motor speed was typically controlled by the user with a foot pedal connected to the sewing machine by a cable with a plug/connector configuration. A0049, Col. 9, ll. 8-11. Motor speed was also controlled "by built-in electronic control circuitry." A0049, Col. 9, ll. 8-12. Because motor speed is related to needle stroke speed, the operator engaging in free motion quilting had to synchronize stitch speed with foot pedal movement and hand motion of the quilt stack in an effort to form high quality stitch patterns.

C. The Solution of the '446 Patent

The '446 Patent reduced the amount of operator skill required by automatically synchronizing the stitch strokes to movement of the stack so a user, with any level of skill, could achieve precise, consistent stitches that are closely and uniformly spaced while moving the stack within a wide range of speeds, and guiding the stack in any direction across the planar bed. A0045, Col. 2, ll. 13 -28.

The ‘446 Patent automatically synchronizes stitch strokes with stack movement by having a detector that measures the movement of the stack across the bed of the apparatus. A0045, Col. 2, ll. 29-33. The detector produces electronic signals corresponding to stack movement as the user moves the stack across the bed of the apparatus. A0047, Col. 5, ll. 14-19. In a preferred embodiment, the detector is an optical sensor that uses reflected light to measure stack movement in both the “X” and “Y” directions. A0045, Col. 2, ll. 45-56. Control circuitry responds to the electronic signals output by the detector to initiate stitch strokes by actuating the stitch head. A0046, Col. 4, ll. 7-10. As the user continues to freely move the stack across the bed of the apparatus, additional stitch stroke commands are successively issued to produce successive stitches synchronized with the user controlled stack movement. A0045, Col. 2, ll. 53-56.

D. The ‘446 Patent Claims

The Decision relied on independent claim 1 of the ‘446 Patent as illustrative of the remaining independent claims 10, 21, 23, 28, and 31. *See* A0004-A0005.

Independent claim 1 of the ‘446 Patent recites:

> 1. An apparatus for stitching together two or more stacked planar layers, said apparatus including:
>
> a stitch head mounted at a fixed location and actuatable to insert a stitch through a stack of two or more planar layers located beneath said stitch head;

> a substantially horizontally oriented bed for supporting said stack of planar layers for manually guided movement across said bed beneath said stitch head;
>
> detector means for detecting movement of a surface of said stack oriented parallel to said bed and proximate to said stitch head for producing signals representing the magnitude of stack surface movement; and
>
> control circuit means responsive to said signals indicating stack surface movement exceeding a certain threshold for actuating said stitch head to insert a stitch through said stack.

A0050, Col. 12, ll. 2-17.

II. Conception, Reduction to Practice, and Patenting

In early 2000, Ralph J. Koerner, the deceased inventor, recognized the difficulties associated with free motion quilting. A0774, ¶ 6; A0816, ¶ 1. Mr. Koerner passed on October 27, 2012 (A0918), prior to the filing of the Complaints (A0491-A0495) (A0496-A0500), and the petitions for *inter partes* review (IPR2013-00364 and IPR2014-00270). Specifically, Mr. Koerner observed the difficulty in synchronizing the hand-controlled movement of a fabric stack with the stitch rate, which, at the time, was controlled by an operator foot pedal. A0816, ¶ 1. Mr. Koerner initially believed he could achieve synchronization mechanically, but was unable to satisfy his goals of performance and reliability and ultimately decided his goal could be achieved automatically via electronics. A0816, ¶1; A0899. Over the succeeding months of early 2000, Mr. Koerner began considering various means for measuring stack movement. A0816, ¶ 1.

In the Spring of 2002, Mr. Koerner assembled a prototype system capable of detecting and responding to fabric movement using a commercially available optical mouse, his personal computer, and a cloth, and he demonstrated his system's ability to his wife, Dorothy Koerner. A0816, ¶ 2; A0899; A0775, ¶ 8.

To further demonstrate the feasibility of his system, Mr. Koerner obtained a used prior art sewing machine in July of 2002. A0816, ¶ 3; A0809; A0899. Mr. Koerner attempted to incorporate an optical sensor for directly detecting movement of a fabric stack, but realized the density of parts under the prior art sewing machine table made that difficult. A0816-A0817, ¶¶ 3-4.

Further efforts by Mr. Koerner resulted in a September 2002 feasibility model of his invention that he made by constructing a small plastic box that contained an optical sensor and associated detector electronics. A0817, ¶ 5; A0899; A0814. The detector electronics included a circuit board and microcontroller constructed by Mr. Koerner for interpreting the X and Y pulse outputs of the optical sensor. A0817, ¶ 5. Mr. Koerner had programmed the microcontroller to accumulate values for X and Y, to calculate the squares of the X and Y values, to sum those squares, and respond to the "distance moved" threshold (sum of squares) for triggering a stitch operation. A0817, ¶ 5. Since this was a feasibility model, Mr. Koerner simulated the stitch operation with a relay and LED light also mounted on the circuit board. A0817, ¶ 5. When fabric was moved

across the optical sensor, the relay actuated in response to the rate of fabric movement. A0817, ¶ 5. When fabric moved at a fast rate, the relay actuated at a fast rate. A0817, ¶ 5; A0810-A0813; A0997, ¶ 6-7; A0999, ¶ 6-7. When the fabric moved at a slower rate, the relay actuated at a slower rate. A0817, ¶ 5; A0810-A0813; A0997, ¶ 6-7; A0999, ¶ 6-7. Since Mr. Koerner had prior experience as an inventor (A0774, ¶¶ 4, 11; A0829, ¶ 3), he documented his efforts with dated diagrams and flow charts. A0817, ¶ 5.

Mr. Koerner contacted his patent attorney, Mr. Art Freilich, in mid-September 2002 to explain his invention. A0817, ¶ 6; A0829-A0830, ¶ 4. Mr. Freilich advised Mr. Koerner to prepare a written disclosure. A0817, ¶ 6; A0829-A0830, ¶ 4. At this time, Mr. Koerner began working on drawings to depict the modifications that would be required to implement his invention on a conventional sewing machine (A0781) as well as drawings of the Optical Mouse Free Motion Detector (A0780). A0817, ¶ 6.

During Mr. Koerner's 73rd birthday celebration on September 21-22, 2002, Mr. Koerner demonstrated his feasibility model to his sons Mike and Steve, both of whom are trained engineers. A0775, ¶ 9; A0810-A0811; A0812; A0818, ¶ 7; A0996-A0997, ¶¶ 4-8; A0998-A0999, ¶¶ 4-8.

On or before October 14, 2002, Mr. Koerner completed his formal written invention disclosure. A0818, ¶ 8; A0800-A0808; A0899.

At the end of October 2002, Mr. Koerner attended the Houston Quilt Festival and spent considerable time inspecting the then state of the art sewing machines. A0818, ¶ 9; A0899.

On November 14, 2002, Mr. Koerner placed orders for several optical mouse development kits to begin constructing his prototype. A0818, ¶ 10; A0899. On November 25, 2002, Mr. Koerner prepared a control circuit schematic for use in his prototype. A0818, ¶11. On December 3, 2002, Mr. Koerner purchased a Sears sewing machine to construct his prototype. A0818, ¶ 12; A0900. On December 4, 2002, Mr. Koerner connected his feasibility detector model to the Sears sewing machine to control stitch rate based on detected fabric movement using the machine's AC motor. A0818, ¶13.

By December 30, 2002, Mr. Koerner had expanded upon his October 14, 2002 invention disclosure, and, on January 2, 2003, he sent the expanded disclosure to Mr. Freilich with the request that he prepare the provisional patent application. A0819,¶ 16; A0831, ¶ 7; A0900. During the months of January and February 2003, Mr. Koerner worked with Mr. Freilich to finalize the provisional patent application, filed as U.S. Provisional Patent Application No. 60/447,159, on February 12, 2003. A0819, ¶ 17; A0831, ¶ 7; A0860-A0887; A0888.

U.S. Non-Provisional Patent Application No. 10/776,355 ("'355 application") was filed on February 11, 2004 and claimed priority to U.S.

Provisional Patent Application No. 60/447,159. A0029. The '355 Application matured into the '446 Patent on April 26, 2005. A0029.

III. The Cited References

The Board relied on Watabe (A0501-A0522) as a § 102(a) reference and relied upon Watabe and Reed (A0570-A0577) as a § 103(a) combination of references.

A. Watabe

1. Discovery of Watabe

In connection with the prosecution of Mr. Koerner's related Japanese application, Mr. Freilich learned of the Watabe reference in late 2008. (A0832, ¶ 9; A0890-A0891). Mr. Koerner and Mr. Freilich examined the Watabe reference and concluded that it failed to suggest Mr. Koerner's solution to the free motion quilting problem addressed by Mr. Koerner's invention, but identified it as relevant. (A0832, ¶ 9). Mr. Freilich advised Mr. Koerner, based on the facts known to him, that Mr. Koerner had conceived his invention prior to the October 8, 2002 publication date of Watabe. (A0832, ¶ 9; A0890-A0891). Recognizing that earlier conception could be relevant in the United States, Mr. Freilich recommended that Mr. Koerner investigate his records to develop a timeline and identify documentation regarding his invention so they could be preserved. (A0832, ¶ 10).

On April 5, 2009, Mr. Koerner sent an email to Mr. Freilich stating that he had uncovered the following documentary evidence (A0832, ¶ 11; A0892):

(1) a September 20, 2002 dated drawing of the "Conventional Sewing Machine Altered For Free Motion";

(2) a September 18, 2002 dated drawing of the "Optical Mouse Motion Detector";

(3) a summary of a demonstration conducted at his 73rd birthday celebration and identification of witnesses Steve and Mike Koerner;

(4) a summary of Mr. Koerner's acquisition of the prior art sewing machine;

(5) and a summary of documents already brought to Mr. Freilich's attention, including a September 16, 2002 key parameters calculation, a September 26, 2002 typewritten table of squares, a September 27, 2002 optical mouse sensor product brief specification, and a September 29, 2002 hand drawn flow chart. A0892.

Mr. Freilich also received a screen shot from Mr. Koerner's computer (A0898) showing that Mr. Koerner last modified the September 20, 2002 drawing of the "Conventional Sewing Machine Altered For Free Motion" (A0896) and the September 18, 2002 drawing of the "Optical Mouse Motion Detector" (A0894) on October 4, 2002. A0832, ¶ 11.

On April 8, 2009, Mr. Koerner sent an email to Mr. Freilich attaching certain documents previously reported to him in the earlier April 5, 2009 email. (A0908-A0914). Those documents included:

(1) A photograph of Mr. Koerner's feasibility model (A0909);

(2) A copy of the September 29, 2002 dated hand drawn flow chart (A0910);

(3) A copy of the hand written document titled "QM Main Parameters" (A0911);

(4) A copy of the November 14, 2002 hand written document titled "Parts List" (A0912);

(5) A copy of the schematic drawings (A0913-A0914).

On April 16, 2009, Mr. Koerner prepared a timeline (A0899-A0900) for his invention based on documentary evidence from his records and sent the timeline to Mr. Freilich for his records. A0833, ¶12.

Mr. Freilich assisted Mr. Koerner in preparing a letter to his licensee, Bernina International AG, outlining the timeline of events and providing the supporting documentation. A0833, ¶13; A0901-A0904.

On May 4, 2009, Mr. Koerner finalized the letter to Bernina International AG along with a CD of the documents referenced in the letter. A0833, ¶¶ 13-14; A0901-A0904; A0915-A0916, ¶¶ 4-6; A0919-A0955.

Mr. Koerner's May 4, 2009 letter and exhibits were stored in the business records of Bernina International AG (A0956-A0957, ¶5-7) and Mr. Koerner's patent attorney, Mr. Freilich. (A0915-A0916, ¶¶ 4-6). Mrs. Koerner found an identical copy of Mr. Koerner's May 4, 2009 letter and other documentation in Mr. Koerner's personal records after his passing. (A0775-A0778, ¶¶ 11-32).

2. Evidence of Conception Prior to the Publication of Watabe

The exhibits relied upon in the IPR proceeding on appeal to establish conception prior to the October 8, 2002 publication of Watabe include exhibits identified and compiled by Mr. Koerner more than four (4) years before the filing of the IPR proceeding on appeal (No. IPR2013-00364). The documentary evidence in this case was obtained from three independent sources: (1) the business records maintained by Mr. Freilich, as a result of his request that Mr. Koerner preserve the information and documentation retrieved as part of his investigation (A0836-A0914; A0919-0955); (2) the business records of Bernina International AG (A0959-A0995); and (3) Mr. Koerner's personal records found by Mrs. Koerner in his workroom after his death (A0779-A0821). In addition to the documents, declarations were provided from witnesses with personal knowledge of the dates and surrounding events.

Although many of the documents were obtained from separate sources, they were considered by the Board to be mere duplicates. Having misconstrued the

evidence as mere duplications, the Board failed to appreciate their significance as business records from multiple independent sources. A0010, fn. 6.

i. Documents Obtained From Mr. Koerner's Workroom by Mrs. Koerner

After Mr. Koerner's passing, Mrs. Koerner reviewed papers in Mr. Koerner's home workroom with the assistance of Mr. Freilich. A0775, ¶ 11. Mrs. Koerner testified that she uncovered various writings and drawings, the majority of which she recognized as being in Mr. Koerner's handwriting. A0775-A0778, ¶¶ 12, 15-18, 21-22, 28, 30 32. These documents included:

(1) A September 16, 2002 hand written document titled "QM Main Parameters" (Ex. 2003) (A0779);

(2) A September 18, 2002 drawing of an "Optical Mouse Free Motion Detector (Ex. 2004) (A0780);

(3) A September 20, 2002 drawing of a "Free Motion Machine" (Ex. 2005) (A0781);

(4) A September 29, 2002 hand written document titled "Mouse Sensor" (Ex. 2006) (A0782);

(5) A November 14, 2002 hand written document titled "Parts List" (Ex. 2007) (A0783);

(6) Schematic drawings (Ex. 2008) (A0783-A0784);

(7) Documented correspondence between Mr. Koerner and Mr. Freilich including invention disclosures (Exs. 2009-2012) (A0786-A0807);

(8) A first envelope including a letter from Maria Shetler, letters of Steve and Mike Koerner, a hand written note, and a photograph of the feasibility model; (Ex. 2013) (A0808-A0814); and,

(9) A second envelope labeled "Durville Letter & Attachments CD 5/4/09" including a copy of Mr. Koerner's letter to Bernina, a handwritten note, and a CD-R (Ex. 2014) (A0815-A0821).

ii. Documents Obtained From the Business Records of Mr. Freilich

Mr. Freilich testified that he maintained a patent application docket folder (A0836-A0837) including business records associated with his transactions with Mr. Koerner (A0829-A0935, ¶¶ 5-22 A0915-A0917, ¶¶ 4-6), which included:

(1) Invention disclosure drafts, patent application drafts, and communications regarding the same (Exs. 2017-2026) (A0838-A0899);

(2) A November 7, 2008 email regarding the Watabe reference (Ex. 2027) (A0890);

(3) An April 5, 2009 email from Mr. Koerner (Ex. 2028) (A0892);

(4) A copy of the September 18, 2002 drawing of an "Optical Mouse Free Motion Detector (Ex. 2029) (A0894);

(5) A copy of the September 20, 2002 drawing of a "Free Motion Machine" (Ex. 2030) (A0896);

(6) A computer screen shot showing the last modification dates of the September 18, 2002 drawing of an "Optical Mouse Free Motion Detector (Ex. 2029) and the September 20, 2002 drawing of a "Free Motion Machine" (Ex. 2030) (A0898);

(7) A timeline prepared by Mr. Koerner on April 16, 2009 regarding his conception and reduction to practice (Ex. 2032) (A0899-A0900);

(8) A copy of Mr. Koerner's May 4, 2009 letter to Bernina (Ex. 2033) (A0901-A0904);

(9) A copy of Steve and Mike Koerner's letters (Exs. 2034-2035) A0905-(A0906);

(10) A copy of an April 8, 2009 email from Mr. Koerner to Mr. Freilich with attachments (Exs. 2036-2041) (A0908-A0914);

(11) A copy of the CD-R titled "Attachments Herr Durville Letter 5/4/09", which included the following 15 documents: (A0919-A0955).

a. A copy of the April 7, 2009 dated letter from Maria Shelter (A0920);

b. A copy of the photograph of Mr. Koerner's feasibility model (A0921);

c. A copy of the September 29, 2002 dated hand drawn flow chart (A0922);

d. A copy of the September 16, 2002 hand written document titled "QM Main Parameters" (A0923);

e. A copy of the September 20, 2002 dated drawing of the "Conventional Sewing Machine Altered For Free Motion"(A0924);

f. A copy of the September 18, 2002 drawing of an "Optical Mouse Free Motion Detector (A0925);

g. A copy of the April 30, 2009 letter from Steve Koerner regarding demonstration of invention (A0926-A0927);

h. A copy of the May 4, 2009 letter from Mike Koerner regarding demonstration of invention (A0928);

i. A copy of the October 14, 2002 document titled "Invention Disclosure Machine for Automatic Quilting" (A0929-A0935);

j. A copy of the November 14, 2002 hand written document listing ordered sample parts (A0936);

k. A copy of the November 25, 2002 hand written document showing schematics for prototype machine (A0937);

l. A copy of a December 3, 2002 receipt for a Sears sewing machine (A0938);

m. A copy of an undated hand written document showing schematics to run AC motor with a December 4, 2002 test date (A0939);

n. A copy of an undated hand written document showin schematics to run AC motor with a December 12, 2002 test date (A0940)

o. A copy of the December 30, 2002 "Invention Disclosure Machine for Free Motion Quilting" (A0941-A0955);

iii. Documents Obtained From the Business Records of Bernina

Bernina's business records had a copy of Mr. Koerner's May 4, 2009 letter, the CD-R titled "Attachments Herr Durville Letter 5/4/09," and the documents thereon (A0956-A0958, ¶¶ 4-7), which included:

(1) A copy of the April 7, 2009 dated letter from Maria Shelter (A0960);

(2) A copy of the photograph of Mr. Koerner's feasibility model (A0961);

(3) A copy of the September 29, 2002 dated hand drawn flow chart (A0962);

(4) A copy of the September 16, 2002 hand written document titled "QM Main Parameters" (A0963);

(5) A copy of the September 20, 2002 dated drawing of the "Conventional Sewing Machine Altered For Free Motion"(A0964);

(6) A copy of the September 18, 2002 drawing of an "Optical Mouse Free Motion Detector (A0965);

(7) A copy of the April 30, 2009 letter from Steve Koerner regarding demonstration of invention (A0966-A0967);

(8) A copy of the May 4, 2009 letter from Mike Koerner regarding demonstration of invention (A0968);

(9) A copy of the October 14, 2002 document titled "Invention Disclosure Machine for Automatic Quilting" (A0969-A0975);

(10) A copy of the November 14, 2002 hand written document listing ordered sample parts (A0976);

(11) A copy of the November 25, 2002 hand written document showing schematics for prototype machine (A0977);

(12) A copy of a December 3, 2002 receipt for a Sears sewing machine (A0978);

(13) A copy of an undated hand written document showing schematics to run AC motor with a December 4, 2002 test date (A0979);

(14) A copy of an undated hand written document showing schematics to run AC motor with a December 12, 2002 test date (A0980);

(15) A copy of the December 30, 2002 "Invention Disclosure Machine for Free Motion Quilting" (A0981-A0995);

A0959-A0995.

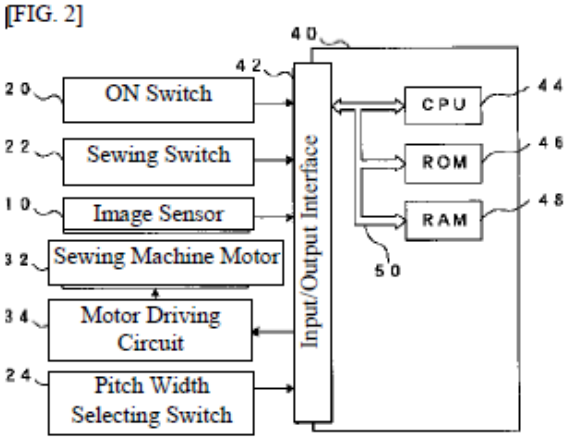
3. The Teachings of Watabe

Watabe concerns the same problem, achieving uniform stitches without the need for a manual foot pedal, as the ‘446 Patent. A0501; A0502-A0503, ¶ 0004. In the words of Watabe, prior art conventional sewing machines required “the user to adjust both the amount of fabric fed and the speed of the sewing needle, meaning that if the user lacks expertise it will not be possible to perform the sewing with the stitch pitch widths aligned uniformly.” A0502-A0503, ¶ 0004. As described in Watabe, conventional prior art sewing machines “have been structured so that the operating speed of the sewing needle can be changed through a pedal operation.” A0502, ¶ 0002.

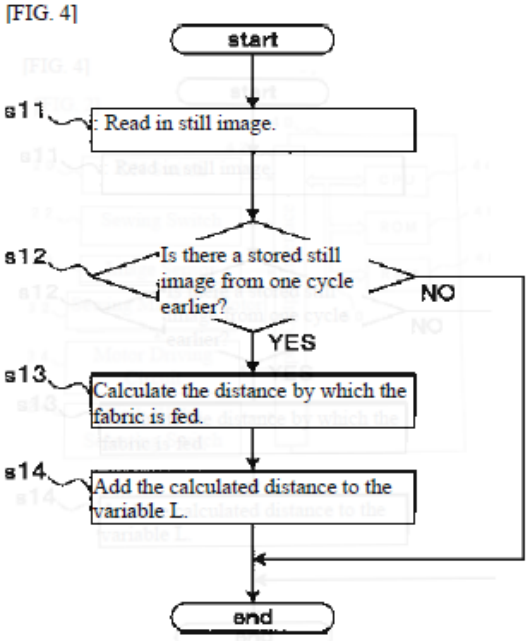
To solve this problem, Watabe proposes a sewing machine comprising “distance measuring means for measuring … a distance by which a fabric is fed; pitch width setting means for setting a stitch pitch width; and needle speed changing means for setting a sewing needle operating speed for forming stitches corresponding to the pitch width based on the distance measured by the distance measuring means and the pitch width set by the pitch width setting means.” A0503, ¶ 0006.

Watabe describes the "distance measuring means" as an "image sensor and a microcomputer" that takes and compares still images over various time intervals, which Watabe illustrates in Figs 2 and 4 reproduced below. A0503, ¶ 0007.

[FIG. 2]



[FIG. 4]



A0511, A0513.

B. Reed

Reed was not of record during the prosecution of the '446 Patent. A0029. Reed was cited, in combination with Watabe, with respect to the decision of obviousness regarding claims 1,2, 5-7, and 23-27 of the '446 Patent, for the sole proposition that Reed provides "an express teaching to the person of ordinary skill in the art that the Watabe prior art-sewing machine can be used to stitch together multiple layers of fabric such as in quilting." A0025.

SUMMARY OF THE ARGUMENT

The Board erred in determining that the Patent Owner had not provided substantial evidence establishing conception prior to the publication date of Watabe.

The Board failed to consider Patent Owner's evidence from the vantage point of one of skill in the art. The Board ignored the intrinsic evidence describing what was known to one of skill in the art in both the admitted prior art section of Watabe and the background and description section of the '446 Patent. This was in direct contrast to the Board's reliance on a patent disclosure as intrinsic evidence of the state of the art in granting rehearing in the related IPR concerning the same '446 Patent. The Patent Owner's evidence as a whole, when viewed from the vantage point of one of skill in the art, shows conception of the claimed inventions, including controlling a sewing machine's stitch head or needle arm so that it actuates in response to detected fabric movement.

The Board confused the requirements of reduction to practice and conception in holding that there was a lack of conception before October 8, 2002. The Board incorrectly applied the requirements for establishing a reduction to practice in its analysis of whether Mr. Koerner conceived the invention prior to October 8, 2002.

The Board also failed to properly evaluate "all pertinent evidence" under the rule of reason analysis. The Board's analysis isolated the evidence and considered each exhibit individually rather than in their totality. The Board misconstrued the independent nature of a majority of the evidence in determining whether Mr. Koerner's story had been sufficiently corroborated under the rule of reason analysis.

As a result of the Board's erroneous rulings regarding the evidence of an earlier conception date, the Board erred in holding that Watabe is applicable prior art under 35 U.S.C. § 102(a); erred in determining that claims 1, 2, 5-7, 10, 12, 13, 17-21, 23-29, 31, 33, and 34 of the '446 Patent are unpatentable under 35 U.S.C. § 102(a); and erred in determining that claims 1, 2, 5-7, and 23-27 of the '446 Patent are unpatentable under 35 U.S.C. § 103(a).

ARGUMENT

I. Standard of Review

This Court reviews the Board's factual findings for substantial evidence and reviews its legal conclusions *de novo*. In re Cuozzo Speed Techs., No. 2014-1301, 2015 U.S. App. LEXIS 1699 at *27 (Fed Cir. February 4, 2015) (citing In re Baxter Int'l, Inc., 678 F.3d 1357, 1361 (Fed. Cir. 2012).

"Substantial evidence is such relevant evidence as reasonable minds might accept as adequate to support a conclusion even if it is possible to draw two

inconsistent conclusions from the evidence." Fleming v. Escort. Inc., No. 2014-1331, 2014-1371, 2014 U.S. App. LEXIS 24419 at *6 (Fed. Cir. December 24, 2014) (quoting Landes Const. Co., Inc. v. Royal Bank of Can., 833 F.2d 1365, 1371 (9th Cir. 1987).

Anticipation under 35 U.S.C. § 102 is a question of fact, In re Hyatt, 211 F.3d 1367, 1371-72 (Fed. Cir. 2000), while obviousness under 35 U.S.C. § 103 is a question of law based on underlying findings of fact, In re Gartside, 203 F.3d 1305, 1316 (Fed. Cir. 2000).

Priority of invention and its constituent issues of conception and reduction to practice are questions of law predicated on subsidiary factual findings. Brown v. Barbacid, 276 F.3d 1327, 1332 (Fed. Cir. 2002); Hitzeman v. Rutter, 243 F.3d 1345, 1353 (Fed. Cir. 2001). Accordingly, this Court reviews the Board's legal conclusions with respect to priority, conception, and reduction to practice *de novo*. Singh v. Brake, 317 F.3d 1334, 1340 (Fed. Cir. 2002).

II. Whether the Board Erred in Determining that Patent Owner's Evidence Was Insufficient to Establish Conception Prior to the Publication of Watabe

The Board erred in determining that the Patent Owner had not provided substantial evidence establishing conception prior to the publication date of Watabe because the Board: (1) failed to consider Patent Owner's evidence from the vantage point of one of skill in the art; (2) confused the requirements of

reduction to practice and conception in holding that there was a lack of conception before October 8, 2002; and (3) failed to properly evaluate "all pertinent evidence" under the rule of reason analysis.

A. The Board Erred By Failing to Consider Patent Owner's Evidence From the Vantage Point of One of Skill in the Art

The Board failed to correctly evaluate Exhibit 2006 (A0782) from the vantage point of one of skill in the art, as evident from the background in both Watabe and the '446 Patent, and concluded that Exhibit 2006 (A0782) failed to "show conception of how to control a sewing machine's stitch head or needle arm so that it actuates in response to detected movement." A0012. Exhibit 2006 (A0782) is Mr. Koerner's September 29, 2002 hand written document titled "Mouse Sensor," that was also found in the business records of Mr. Frelich (A0833, ¶ 15; A0910; A0916, ¶ 6(4); A0922), in the business records of Bernina (A0957, ¶ 7(4); A0962), and in Mr. Koerner's workroom (A0776, ¶ 15).

The Board's Decision focused on Exhibit 2006 (A0782) and concluded it, standing alone, failed to show conception of the following claim limitations that the Board characterized as "key":

Claim 1: "control circuit means responsive to said signals indicating stack surface movement exceeding a certain threshold for actuating said stitch head to insert a stitch through said stack"

Claim 10: "control circuitry responsive to detected movement of said fabric layer surface for controlling actuation of said needle arm"

> Claim 21: "control means responsive to a translational movement of said stack of a magnitude exceeding a certain threshold for causing said needle to execute said cyclic movement."

A0010. The Decision goes on to state:

> Exhibit 2006 illustrates, in flow diagram format, a basic algorithm in which x and y pulses are inputted to a "mouse" or "mouse sensor," calculations are made based on those x and y pulses, and a comparison is made to a "set stitch length" to decide whether to stitch. Ex 2006. **The document does not show conception of how to control a sewing machine's stitch head or needle arm so that it actuates in response to detected movement. Further, Patent Owner has not presented evidence that mere ordinary skill in the art would have been required to reduce to practice the invention, as ultimately claimed, which required controlling the stitch head or needle arm so that it actuates in response to detected movement**.

A0012 (emphasis added). The Board did not address the other exhibits, namely Exhibits 2004, 2005 (A0780-A0781), which Patent Owner contends show conception of the other claim limitations (Paper 17, A0215-A0244), and focused exclusively on Exhibit 2006. (A0010-A0012).

With respect to establishing conception, this Court has held:

> Conception is the touchstone of inventorship, the completion of the mental part of invention. Sewall v. Walters, 21 F.3d 411, 415 (Fed. Cir. 1994). It is "the formation in the mind of the inventor, of a definite and permanent idea of the complete and operative invention, as it is hereafter to be applied in practice." Hybritech Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1376 (Fed. Cir. 1986) (citation omitted). Conception is complete only when the idea is so clearly defined in the inventor's mind that only ordinary skill would be necessary to reduce the invention to practice, without extensive research or experimentation. Sewall, 21 F.3d at 415; see also Coleman

> v. Dines, 754 F.2d 353, 359 (Fed. Cir. 1985) (conception must include every feature of claimed invention). Because it is a mental act, courts require corroborating evidence of a contemporaneous disclosure that would enable one skilled in the art to make the invention. Coleman v. Dines, 754 F.2d at 359.

Burroughs Wellcome Co. v. Barr Labs., Inc., 40 F.3d 1223, 1228 (Fed. Cir. 1994) (parallel citations omitted). "Because conception is a mental act, it must be proven by evidence showing that the inventor has disclosed to others and what that disclosure means to one of ordinary skill in the art." In re Jolley, 308 F.3d 1317, 1321 (Fed. Cir. 2002) (quoting Spero v. Ringold, 377 F.2d 652, 660 (C.C.P.A. 1967))(internal quotations omitted).

Typically, conception is shown by an inventor's testimony aided by corroboration evidence, or through physical exhibits and documentary evidence. See Mahurkar v. C.R. Bard, Inc., 79 F.3d 1572, 1577-78 (Fed. Cir. 1996). An inventor's testimony, standing alone is insufficient to prove conception -- some form of corroboration must be shown. Price v. Symsek, 988 F.2d 1187, 1195 (Fed. Cir. 1993) (citing Amax Fly Ash Corp. v. United States, 514 F.2d 1041, 1047 (Ct. Cl. 1975)). With respect to the use of physical exhibits and documentary evidence to establish conception, this Court does not require corroboration evidence. See Mahurkar, 79 F.3d at 1577-78; see also Price, 988 F.2d at 1195-96 (finding that what a drawing discloses need not be supported by corroborating evidence, as

"[o]nly the inventor's testimony requires corroboration before it can be considered").

Regardless of the type of evidence set forth to prove conception, the "Board must nonetheless weigh that evidence from the vantage point of one of skill in the art." Brown v. Barbacid, 276 F.3d 1327, 1334 (Fed. Cir. 2002) (citing Mahurkar v. C.R. Bard, Inc., 79 F.3d 1572, 1578 (Fed. Cir. 1996) (stating that the trier of fact can conclude for itself what documents show, aided by testimony about the meaning of the exhibit to one skilled in the art); see also In re Jolley, 308 F.3d at 1321 ("Because conception is a mental act, 'it must be proven by evidence showing what the inventor has disclosed to others and what that disclosure means to one of ordinary skill in the art.'" (quoting Spero v. Ringold, 377 F.2d 652, 660 (C.C.P.A. 1967))).

1. The Board Ignored the Intrinsic Evidence of What Was Known To One of Skill In the Art

In evaluating Exhibit 2006 (A0782), the Board ignored the intrinsic evidence of what was known to one of skill in the art. Such evidence was presented in the admitted prior art background section and description of the '446 Patent and in the admitted prior art section of Watabe. Ignoring this intrinsic evidence regarding the state of the art and the level of skill led the Board to reach the erroneous conclusion that the entirety of Patent Owner's evidence was insufficient to establish conception prior to the publication of Watabe.

a. The Background and Description of the ‘446 Patent Describes What Was Known to One of Skill in the Art

The ‘446 Patent discloses that motor speed control capability was a common feature of most modern sewing machines. A0049, Col. 9, ll. 8-10. Motor speed, *i.e.*, the speed of the sewing machine’s stitch head or needle arm, was typically controlled by the user, with a foot pedal. A0049, Col. 9, ll. 8-11. One of skill in the art would have known that the sewing needle speed was controlled by a signal from an external source, *i.e.*, a foot pedal, and it would not require undue experimentation by one of ordinary skill in the art to use a different signal source for that speed control.

b. The Admitted Prior Art Section of Watabe Also Confirms What Was Known to One of Skill in the Art

Watabe confirms what was known to one of skill in the art and is in agreement with both the admitted prior art background section and the description of the ‘446 Patent. Watabe provides that “[c]onventionally, in sewing machines that can perform sewing while the amount of fabric fed is adjusted manually have been structured so that **the operating speed of the sewing needle can be changed through a pedal operation**.” A0502, ¶ 0002. (emphasis added). Watabe confirms that one of skill in the art at the time of the invention would have been aware that

the operating speed of the sewing needle could be manipulated via an external source, *i.e.*, a foot pedal, that provided a control signal. A0502, ¶ 0002.

Watabe provides very little description, other than the above, regarding controlling the operating speed of the sewing needle via an external foot pedal source. This is because this was known. As the Board reasoned in its December 30, 2014 Decision Granting Petitioner's Request for Rehearing in the co-pending IPR proceeding, IPR 2014-00270, involving the very same'446 Patent, there is no need to further describe what is known:

> Watabe's election not to describe what was known is consistent with applicable precedent. Carnegie Steel Co. v. Cambria Iron Co., 185 U.S. 403, 437 (1902) (an inventor may assume that what was already known in the art of manufacturing steel was known to those skilled in the art); Webster Loom Co. v. Higgins, 105 U.S. 580, 586 (1881) (an inventor may begin at the point where the invention begins, and describe what has been made that is new, and what it replaces of the old; that which is common and well known is as if it were written out in the patent and delineated in the drawings).

A1122.

The Decision on appeal here never mentions the admitted intrinsic prior art evidence showing what was generally known to one of skill in the art at the time of the '446 Patent. This failure to address the intrinsic evidence of prior knowledge is contrary to the Board's holding in the related IPR concerning the same '446 Patent. A1122. Ignoring this intrinsic evidence led the Board to reach the erroneous

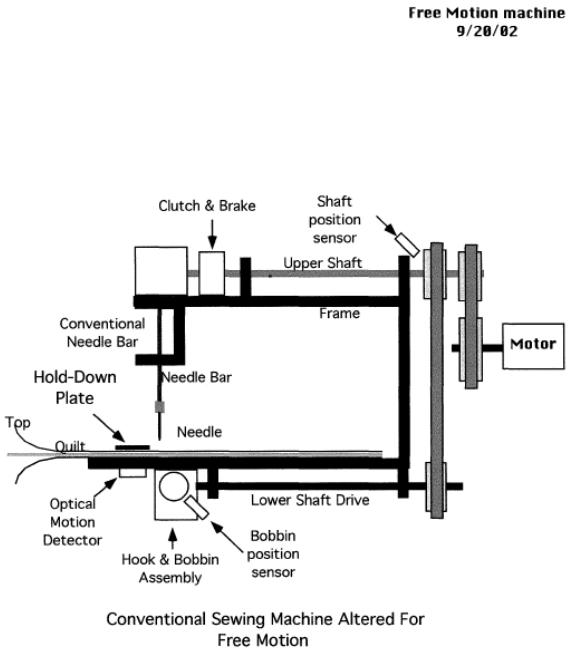
conclusion that the entirety of Patent Owner's evidence was insufficient to establish conception prior to the publication of Watabe.

2. From the Vantage Point of One of Skill in the Art, Exhibits 2004-2006 Show Conception of Controlling a Sewing Machine's Stitch Head or Needle Arm So That It Actuates In Response to Detected Movement

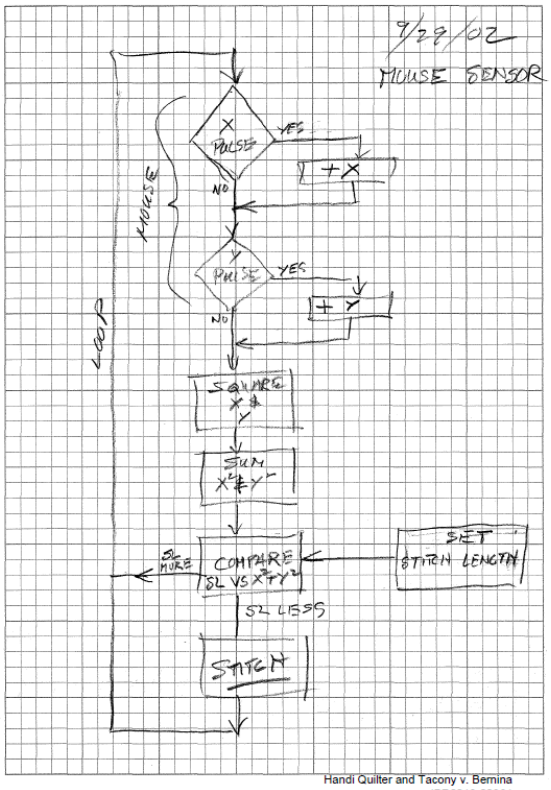
Exhibits 2004-2006 (A0780-A0782), when properly viewed from the vantage point of one of skill in the art, clearly show that Mr. Koerner had a definite and permanent idea of the complete and operative invention, as it was to be applied in practice. As explained above, both the background and description of the '446 Patent and the prior art section of Watabe provided intrinsic evidence as to what was known at the time of the invention about controlling motor speed and that only ordinary skill would be necessary to reduce the invention to practice in view of Exhibits 2004-2006 (A0780-A0782).

The September 20, 2002 Exhibit 2005 is a memorialized depiction of Mr. Koerner's definite and permanent idea of the complete and operative invention, as it was to be applied in practice. A0781. Exhibit 2005 is a "conventional sewing machine altered for free motion" quilting. A0781. Exhibit 2004 shows the addition of an optical motion detector in the bed portion of the sewing machine structure. A0780. The September 29, 2002 Exhibit 2006 is a flow diagram for programming a circuit board including a microcontroller for connecting the optical motion sensor (*i.e.*, mouse sensor) to the sewing machine motor in Exhibit 2005 to provide a stich

based on the movement detected by the optical motion sensor. A0782. The microcontroller is used to interpret the X and Y pulse outputs of the optical motion sensor as it responds to fabric motion. A0782. Exhibits 2005 (A0781) and 2006 (A0782) are reproduced below.



Conventional Sewing Machine Altered For Free Motion



Handi Quilter and Tacony v. Bernina
IPR2013-00364
Bernina Exhibit 2006

The circuitry, as evidenced by the flow diagram, allows the microcontroller to accumulate detected values for X and Y, to calculate the squares of the X and Y values and sum those squares to respond to a "distance moved" threshold for triggering a stitch operation. A0782; A0817, ¶5. The stitch command is constantly repeated in a loop, as movement of the fabric is continuously detected. A0782.

With respect to conception of controlling a sewing machine's stitch head or needle arm so that it actuates in response to detected movement, the question to be asked must be, what does Exhibit 2006 show when weighed from the vantage point of one of skill in the art? See Brown v. Barbacid, 276 F.3d 1327, 1334 (Fed. Cir. 2002). Motor speed control was a common feature of known sewing machines. One of skill in the art would have known that motor speed could be controlled via an external source and would understand Exhibit 2006 as providing the circuitry instructions to control a sewing machine's stitch head or needle arm so that it actuates in response to detected movement.

The controlling law requires that the disclosure be sufficient to enable a person of ordinary skill in the art to "reduce the invention to practice, without extensive research or experimentation." Burroughs Wellcome Co. v. Barr Labs., Inc, 40 F.3d 1223, 1228 (Fed. Cir. 1994). The law does not require that "the final size and shape of every part and the location of every nut, screw, and bolt must be exactly foreseen before the conception of an apparatus can be said to be complete." In re Tansel, 253 F.2d 241, 243 (C.C.P.A. 1958). In the present matter, the stich command of the flow chart shown in Ex. 2006 must be attributed some meaning when viewed by one of ordinary skill in the art in the context of a connection to a sewing machine. It should not be viewed in the abstract or in isolation without such knowledge.

The issue on appeal here is strikingly similar to that in In re Tansel. In In re Tansel, the sole issue was whether the appellant had established conception of the invention prior to the priority date of another reference. 253 F.2d at 242-43. The Board of Appeals for the United States Patent Office's holding, "that appellant had not conceived the invention prior to November 15, 1944, [was] based solely on the finding that he did not have 'a definite and permanent idea of the complete and operative concept of the flash circuit component of his invention,' prior to that date." Id. In reaching that conclusion, the Board reasoned that the evidence of record showed that

> [P]rior to November 15, 1944, [the inventor] had prepared a written description of his invention "including the concept that a flash tube, photo-cell timing circuit, and electronic equipment to flash said tube would be used in the combination." [The inventor did] not contend that his disclosures prior to November 15, 1944, included a specific flash circuit or timing means, and admits that if he were claiming to be the inventor of a flash circuit, such disclosures would be insufficient. It is his position, however, that such circuits were old and that those skilled in the art would have understood, on the basis of his disclosures, how they could be employed to produce the desired result.

Id.at 243. The C.C.P.A. reversed the Board's holding of a lack of conception, and held that the inventor had in fact met the test for conception

> The problem involved is essentially one of accurately coordinating the timing of the flash with the remaining operations of the apparatus. Such coordination is, of course, broadly old in a wide variety of mechanisms, and it does not appear that its application to appellant's device presented any problems of peculiar difficulty. If we correctly understand the invention, there is no apparent reason why a skilled

> mechanic could not have readily worked out an operative apparatus, on the basis of appellant's disclosures, for performing the necessary functions.

Id. at 244.

Like the inventor in In re Tansel, Mr. Koerner invention had sufficiently evidenced, by the admitted prior art in both Watabe and the '446 Patent, that one of skill in the art knew the operating speed of the sewing needle could be controlled via an external source, *i.e.*, a foot pedal. There is no apparent reason why a skilled mechanic could not have readily worked out an operative apparatus for performing the necessary functions on the basis of Mr. Koerner's disclosures, specifically Exhibit 2004-2006. See id. at 244.

When viewed from the vantage point of one of skill in the art, Exhibits 2004-2006 are sufficient to enable a person of ordinary skill in the art to control a sewing machine's stitch head or needle arm so that it actuates in response to detected movement without extensive research or experimentation. The Board failed to consider Patent Owner's evidence from the vantage point of one of skill in the art and erred in determining that Patent Owner's evidence was insufficient to establish conception prior to the publication of Watabe.

B. The Board Confused the Requirements of Reduction To Practice and Conception in Holding That There Was a Lack of Conception Before October 8, 2002

The Board erred by confusing the requirements of reduction to practice and conception in holding that there was a lack of conception before October 8, 2002. As noted above, conception is "the formation in the mind of the inventor, of a definite and permanent idea of the complete and operative invention, as it is hereafter to be applied in practice." Hybritech Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1376 (Fed. Cir. 1986). This Court has held that "[c]onception is complete only when the idea is so clearly defined in the inventor's mind that only ordinary skill would be necessary to reduce the invention to practice, without extensive research or experimentation," and that "[a]n idea is definite and permanent when the inventor has a specific, settled idea, a particular solution to the problem at hand, not just a general goal or research plan he hopes to pursue." Dawson v. Dawson, 710 F.3d 1347, 1352 (Fed. Cir. 2013) (quoting Burroughs Wellcome Co. v. Barr Labs., Inc., 40 F.3d 1223, 1228 (Fed. Cir. 1994).

With respect to Exhibit 2006, the Board held that "Patent Owner has not presented sufficient evidence that the inventor had 'a definite and permanent idea of the complete and operative invention,' prior to October 8, 2002." A0012. In reaching this conclusion, the Board reasoned that "Mr. Koerner stated that it wasn't until November 25, 2002, that he '[s]ettled on control circuit for prototype

machine.' Ex. 2032." A0012. This statement blurs the line of where conception ends and where reduction to practice begins, and unfairly attributes elements of the reduction to practice to Mr. Koerner's evidence of conception. See Fox Group, Inc. v. Cree, Inc., 700 F.3d 1300, 1305 (Fed. Cir. 2012) ("Reduction to practice and conception are separate and distinct concepts and tests; we will not combine them"). Just because Mr. Koerner had not *settled* on the final type of control circuit to use in a prototype by October 8, 2002, that does not mean that he did not have a *definite and permanent* idea of the complete and operative invention prior to October 8, 2002. It is well settled that:

> The point of time at which invention, in such sense as to merit the protection of law, dates is neither when the first thought of it is conceived, nor when the practical working machine is completed, but it is when the thought or conception is practically complete; when it has assumed such shape in the mind that it can be described and illustrated; when the inventor is ready to instruct the mechanic in relation to putting it in working form; when the 'embryo' has taken some definite form in the mind and seeks deliverance, and when this is evidenced by such description or illustration as to demonstrate its completeness. . . . **The true date of invention is at the point where the work of the inventor ceases and the work of the mechanic begins**. Up to that point he was inventing, but had not invented, and he must have invented before the law will come to his protection."

Mergenthaler v. Scudder, 11 App. D.C. 264, 277 (1987) (quoting Cameron & Everett v. Brick, 1871 Dec. Comm'r Pat. 89, 90 (1871)) (emphasis added).

Based on the evidence of record, the work of the ***inventor***, Mr. Koerner, ceased prior to October 8, 2002 when he had identified the problem to be solved

(the difficulty of coordinating user hand movement and user controlled needle speed (A0816, A0502, ¶¶ 1-2)), and had devised a specific solution to that problem (controlling needle speed automatically with electronics based on the detected fabric motion attributed by the user with an optical sensor (A0816, ¶ 2)).

Mr. Koerner demonstrated his ability to detect fabric with a computer mouse in the Spring of 2002. A0816, ¶ 2; A0775, ¶¶ 7-8. After demonstrating his ability to detect fabric with a computer mouse in the Spring of 2002, Mr. Koerner set out to building a functioning prototype that would use the detected movement information to control the needle speed or stitch rate. A0816-A0817, ¶ 3. After obtaining the sewing machine from Ms. Shetler in July of 2002 (A0816, ¶ 3) and discovering it was unsuitable for his purposes, Mr. Koerner turned his attention to constructing a feasibility model that would employ an LED and relay as the proxy for the stitching operation of the sewing machine. A0817, ¶¶ 4-5. As witnessed by both Mr. Koerner's sons, Steve and Mike Koerner, both trained engineers, the relay actuated in proportion to the speed of fabric motion – a proxy for how the stitch head would operate in the same situation. A0810-A0812; A0996-A0997. In mid-September 2002, at the request of his patent attorney, Mr. Koerner set out to define his permanent idea of the complete and operative invention, as embodied in the feasibility model, on paper, resulting in Exs. 2004-2006 (A0780-A0782). A0817, ¶ 6.

Having reached a definite and permanent idea of the complete and operative invention in his mind, as embodied in his feasibility model and memorialized in drawings and flow charts, the work of Mr. Koerner as the **mechanic** began. All that was left at this point was the mechanic's work needed to complete the modification an operative sewing machine.

The ‘446 Patent demonstrates that only the work of the mechanic possessing the knowledge of ordinary skill in the art was required after the events of preceding October 8, 2002 to reduce the invention to practice. Fig. 16 of the ‘446 Patent (below) and the corresponding specification depict an embodiment of Mr. Koerner’s invention for retrofitting a conventional sewing machine with a detector and circuitry to control motor speed and eliminate the foot pedal. A0044; A0050, Col. 11, ll. 23-54. Retrofitting the detector to a conventional sewing machine and applying the control signal via the foot pedal port is surely the work of the **mechanic**, not the inventor. A0044; A0050, Col. 11, ll. 23-54.

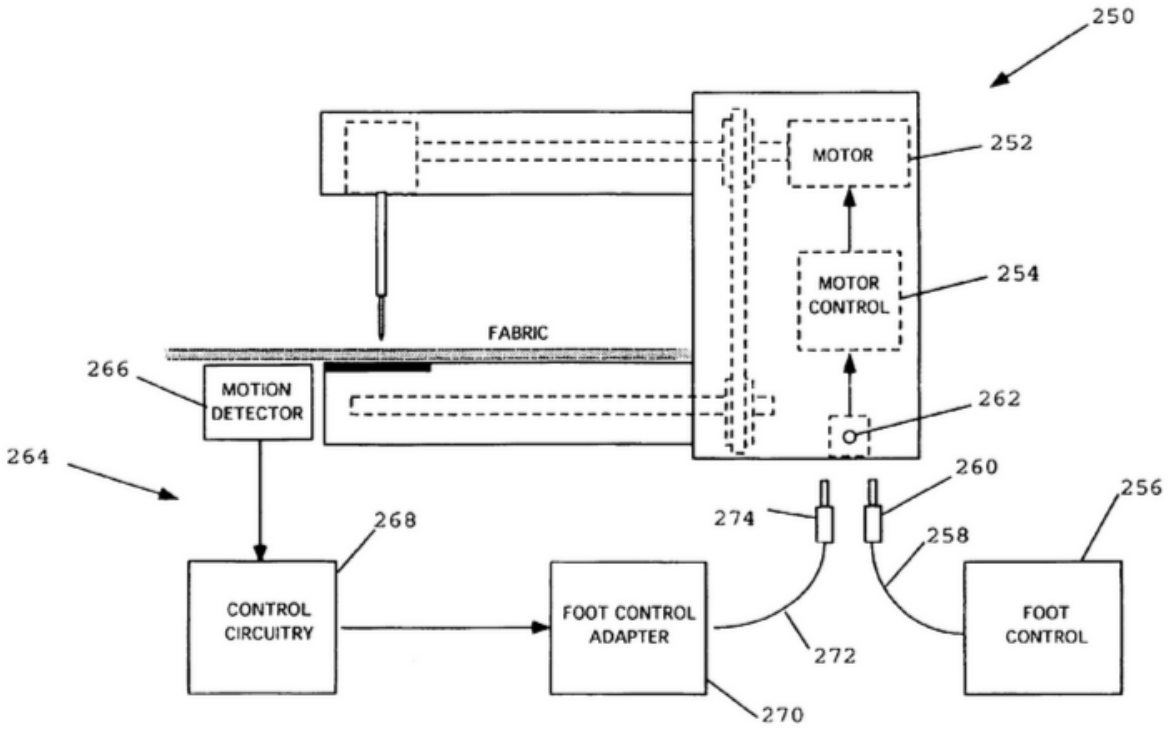


FIGURE 16

The Board erred by concluding Mr. Koerner had not conceived of his invention prior to October 8, 2002 because he had yet to settle on a control circuit for prototype machine, because this is an action attributable to the mechanic in the determination of reduction to practice.

C. The Board Erred as a Matter of Law By Failing to Properly Apply the "Rule of Reason" Analysis

As stated above, "[b]ecause conception is a mental act, it must be proven by evidence showing that the inventor has disclosed to others and what that disclosure means to one of ordinary skill in the art." In re Jolley, 308 F.3d 1317, 1321 (Fed

Cir. 2002) (quoting Spero v. Ringold, 377 F.2d 652, 660 (C.C.P.A. 1967)) (internal quotations omitted). Typically, conception is shown by an inventor's testimony aided by corroboration evidence, or through physical exhibits and documentary evidence. See Mahurkar v. C.R. Bard, Inc., 79 F.3d 1572, 1577-78 (Fed. Cir. 1996). An inventor's testimony, standing alone is insufficient to prove conception -- some form of corroboration must be shown. Price v. Symsek, 988 F.2d 1187, 1195 (Fed. Cir. 1993) (citing Amax Fly Ash Corp. v. United States, 514 F.2d 1041, 1047 (Ct. Cl. 1975)).[1] As this Court has explained, this rule is not new to patent law:

> Conception by an inventor, for the purpose of establishing priority, can not be proved by his mere allegation nor by his unsupported testimony where there has been no disclosure to others or embodiment of the invention in some clearly perceptible form, such as drawings or model, with sufficient proof of identity in point of time. For otherwise[,] such facile means of establishing priority of invention would, in many cases, offer great temptation to perjury, and would have the effect of virtually precluding the adverse party from the possibility of rebutting such evidence. Hence it has been ruled in many cases that the mere unsupported evidence of the alleged inventor, on an issue of priority, as to . . . conception and the time thereof, can not be received as sufficient proof of . . . prior conception.

Price, 988 F.2d at 1194-95.

The corroboration requirement is "a flexible, rule-of-reason demand for independent evidence that, **as a whole**, makes credible the testimony of the

[1] The "corroboration requirement" may also apply to certain documents, if unwitnessed, unsigned, or unseen by any witness until after a proceeding is declared. See Reese v. Hurst, 661 F.2d 1222, 1232 (CCPA 1981).

purported prior inventor with regard to conception and reduction to practice of the invention as claimed." Fleming v. Escort Inc., No. 2014-1331, 2014-1371, 2014 U.S. App. LEXIS 24419 at *12 (Fed. Cir. December 24, 2014) (citing Sandt Tech., Ltd. v. Resco Metal & Plastics Corp., 264 F.3d 1344, 1350-51 (Fed. Cir. 2001). The "rule of reason" analysis requires that "an evaluation of all pertinent evidence must be made so that a sound determination of the credibility of the [alleged] inventor's story may be reached." Price, 988 F.2d at 1195.

The Board erred by failing to properly apply the rule of reason analysis when it: (1) evaluated the evidence offered to corroborate the inventor's story, as told from the grave through letters, timelines, and outlines memorializing his journey to the grant of the '446 Patent, in isolation, and not as a whole as required; and, (2) misconstrued the independent nature of the corroborating evidence provided by Mr. Freilich, Mrs. Koerner, Steve Koerner, and Mike Koerner.

1. The Board Erred By Evaluating The Exhibits Individually and Not as a Whole

a. The Board Did Not Examine Exhibit 2006 In Light of All of the Exhibits

As noted above, the Board focused on a single Exhibit, Exhibit 2006[2] (A0782), and concluded it alone failed to show conception of limitations the Board characterized as "key." A0010-A0012. Patent Owner submitted Exhibit 2006, as

[2] Exhibit 2006 is a hand written document titled "Mouse Sensor" dated Sept. 29, 2002.

well as numerous other Exhibits, to corroborate Mr. Koerner's timeline of conception. Rather than viewing Exhibit 2006 in the context of Mr. Koerner's timeline and considering what was known to those skilled in the art, especially in view of the other numerous pieces of corroborating evidence, the Board focused on the alleged shortcomings of a single isolated document, Exhibit 2006. A0012-A0013. Under the rule of reason analysis, the Board is required to consider all other available evidence to determine the credibility of the inventor's story, i.e., that he had a definite and permanent idea of the complete and operative invention, as it was to be applied in practice. See Price v. Symsek, 988 F.2d 1187, 1195 (Fed. Cir. 1993). This, the Board did not do.

For example, the Board should have looked to the fact that Mr. Koerner built a feasibility model and demonstrated that model to his sons, Steve and Mike Koerner, at his birthday celebration in September of 2002. The testimony from Steve and Mike clearly describes the feasibility model operating in accordance with the flow diagram of Exhibit 2006. For example, Steve Koerner's letter provides a detailed recitation of the functionality of the feasibility model, as witnessed by him:

> [W]hen the fabric was moved [across the sensor], the relay clicked on and off at a rate that was related to the speed of motion of the fabric. The relay appeared to actuate smoothly in proportion to the speed of fabric motion regardless of the direction of fabric movement, including straight lines, arcs, and circles. The relay buzzed when the fabric was moved fast and clicked slowly when the fabric was moved

> slowly. My father explained that the circuitry of the model included a preset threshold for recognizing a fixed increment of fabric motion, so that the relay would actuate once for each such increment of fabric movement. He explained that his intention was to cause the sewing machine to make a stitch with each actuation of the relay.

A0810-A0811. The above statement was affirmed in Steve Koerner's declaration, which is also in accord with this previous account. A0998-A0999.

Similarly, Mike Koerner's letter states:

> When we moved fabric across the upper surface of the box the relay actuated at approximately the rate of fabric movement. It did so regardless of the direction of fabric movement. It clicked fast when the fabric was moved fast and it clicked slowly when the fabric was moved slowly. My father explained that he intended to use the contacts of the relay to control the motor of a sewing machine, thus controlling the rate of stitching.

A0812. The above statement was affirmed in Mike Koerner's declaration, which is also in accord with this previous account. A0996-A0997. The evidence documenting this event provides sufficient corroboration that the inventor had a definite and permanent idea of the complete and operative invention prior to October 8, 2002, by demonstrating the principles of Exhibit 2006 when applied in a working model. As this Court has stated:

> Corroborating evidence may take many forms. Reliable evidence of corroboration preferably comes in the form of physical records that were made contemporaneously with the alleged prior invention. See Sandt Tech., Ltd. v. Resco Metal & Plastics Corp., 264 F.3d 1344, 1350-51 (Fed. Cir. 2001) ("Documentary or physical evidence that is made contemporaneously with the inventive process provides the most reliable proof that the inventor's testimony has been corroborated." (citing Woodland Trust v. Flowertree Nursery, Inc.,

> 148 F.3d 1368, 1373 (Fed. Cir. 1998))). Circumstantial evidence about the inventive process may also corroborate. See Knorr v. Pearson, 671 F.2d 1368, 1373 (CCPA 1982) ("Sufficient circumstantial evidence of an independent nature can satisfy the corroboration rule."). Additionally, oral testimony of someone other than the alleged inventor may corroborate. See Price, 988 F.2d at 1195-96.

Trovan, Ltd. V. Sokymat Sa, 299 F.3d 1292, 1302-1303 (Fed. Cir. 2002).

The Board also failed to consider whether Exhibit 2006 was likely created on the date it bears in light of all of the evidence. On page 13 of the Decision, the Board stated:

> Patent Owner has not persuaded us that the document (Ex. 2006) was created on the date that it bears, September 29, 2002. It may have been, but perhaps not. The record lacks inventor testimony. We have only an unsworn statement from the inventor that was made years later. *See* Ex. 2033 (letter dated May 4, 2009 from Mr. Koerner to Bernina/Fritz Gegauf AG); *see also* Price, 988 F.2d at 1195 n.3 ("Factors bearing on the inventor's credibility … are: (1) delay between the event and the trial …."). Also, in his statement, Mr. Koerner does not state that he prepared the document on September 29, 2002. He says he prepared it "on or before September 29, 2002." Ex. 2033 ¶ 5. Thus, according to Mr. Koerner, the date appearing on his document was not necessarily the date the document was created or last-modified.
>
> **The record lacks any evidence, apart from Mr. Koerner, that this document existed on (or before) September 29, 2002.**

A0013. (Emphasis added).

While the record does not have and could not have direct inventor testimony due to Mr. Koerner's passing, the record is full of circumstantial evidence supporting the likelihood that Exhibit 2006 was created no later than the date it

bears. See Knorr v. Pearson, 671 F.2d 1268, 1373 (C.C.P.A. 1982) ("it [is] not necessary … to produce an actual over-the-shoulder observer to satisfy the corroboration requirement; rather, sufficient circumstantial evidence of an independent nature can satisfy the corroboration rule.").

The fact that Mr. Koerner built and demonstrated a feasibility model to his sons that operated in accordance with Exhibit 2006 is circumstantial evidence that Mr. Koerner had a definite and permanent idea of the complete and operative invention, including the necessary programing of the microcontroller of the feasibility model, at the time he built the feasibility model. Furthermore, the progressive creation dates of the other dated documents (*i.e.*, the September 18, 2002 drawing of an "Optical Mouse Free Motion Detector" (A0780) and the September 20, 2002 drawing of a "Free Motion Machine" (A0781)), and the later demonstration to his sons on September 21-22, 2002, support the likelihood that Mr. Koerner committed to paper, on Exhibit 2006, his conception of how to control a sewing machine's stitch head or needle arm so that it actuates in response to detected movement.

The evidence as a whole tends to corroborate that Exhibit 2006 was indeed created on the date it bears, but certainly before October 8, 2002. While the Board summarily evaluated a limited number of additional exhibits, including, the declarations of Mrs. Koerner, Mr. Freilich, Steve and Mike Koerner, and the

statement of Maria Shetler, that evaluation focused on the exhibits individually and not as a whole.

b. The Board Did Not Consider Mrs. Koerner's Testimony In Light of All of the Exhibits

The Board attacks Mrs. Koerner's testimony (A0774-A0778) individually, but does not view it in light of all of the evidence. When viewed in the context of the entirety of the submitted evidence, Mrs. Koerner's circumstantial and testimonial evidence provides corroborating evidence as to Mr. Koerner's inventive process. While Mrs. Koerner's testimony regarding the demonstration in the spring of 2002, may not show conception of the *complete* invention at that time, it sheds light on the inventive process and next steps (*i.e.*, seeking out an experimental sewing machine to experiment with) which was confirmed by other evidence such as Maria Shelter's April 7, 2009 letter. A0809.

Even though Mrs. Koerner does not state she witnessed the September 2002 demonstration of the feasibility model, as noted by the Board, her testimony confirms the event dates, and provides corroboration as to the attendees of the birthday celebration, especially when viewed in conjunction with the declarations of Mr. Koerner's sons, Steve and Mike.

c. The Board Failed to Consider the Proffered Testimony of Steve and Mike Koerner In Light of All of the Evidence

Like Mrs. Koerner's testimony, the Board attacks Steve and Mike Koerner's letters and declarations individually and fails to view them in light of all of the evidence as required by the rule of reason analysis. The Decision states that neither "the sons' letters (Exs. 2034–2035), or even the sons' declarations (Exs. 2047–2048), which were submitted not in support of Patent Owner's Response but rather in response to Petitioner's evidentiary objections to the son's letters[3], purports to show controlling actuation of a machine's stitch head or needle arm in response to the detection of fabric movement." A0016. While the Board correctly states that the witnessed demonstration was not of an actual working prototype, the Board failed to evaluate the demonstration in light of all the evidence. As is clear from the totality of the evidence, the demonstration was of a feasibility model, to show the ability to control actuation of a machine's stitch head or needle arm in response to the detection of fabric movement via an LED and relay proxy. As other evidence makes clear, *e.g.*, Mr. Koerner's letter to Durville (Ex. 2014-2) (A0816-A0819), a feasibility model was constructed at the time in lieu of a working prototype, because the prior art sewing machine in Mr. Koerner's possession was not a suitable starting point for building a prototype.

[3] A party in an IPR proceeding may respond to a challenger's evidentiary objections by submitting supplemental evidence. 37 C.F.R. § 42.64(a)(2).

2. The Evidence, When Evaluated as a Whole, Corroborates Mr. Koerner's Statements Proving Prior Conception

Had the Board properly considered Mr. Koerner's contemporaneously made records, the circumstantial evidence and accounts of Maria Shelter, Mrs. Koerner, Steve Koerner, Mike Koerner, Mr. Freilich, and Bernina's records, the Board would have reached the correct conclusion that Mr. Koerner conceived of his invention prior to the October 8, 2002 publication date of Watabe.

The evidence of record shows that Mr. Koerner had a definite and permanent idea of the complete and operative invention, as it was to be applied in practice prior to October 8, 2002. Where one exhibit may fall short, the balance of exhibits removes any doubt as to whether Mr. Koerner conceived his invention prior to the October 8, 2002 publication date of Watabe.

3. The Board Misconstrued the Independent Nature of the Corroborating Evidence

The Board misconstrued the independent nature of the corroborating evidence presented in this case. The Decision erroneously concludes that there was no proffer of independent testimony regarding Mr. Koerner's 73 birthday demonstration. A0016. The Board discounts the independent nature of the letters of Steve and Mike Koerner, even though those letters were signed by Steve and Mike Koerner. The Board further ignores the declarations submitted by Mike Koerner (A0996-A0997) and Steve Koerner (A0998-A0999) affirming the

September 2002 events as personally witnessed by them and confirming the substance of their previously submitted letters. There is no legal requirement, and the Board fails to cite any authority for the proposition, that a witness statement reviewed and signed by that witness must have been prepared by that witness, and **only** by that witness. A0016. Moreover, this Court has stated that "[i]ndependent corroboration may consist of testimony of a witness…." In re Garner, 508 F.3d 1376, 1380 (Fed. Cir. 2007) (quoting Reese v. Hurst, 661 F.2d 1222, 1225 (C.C.P.A. 1981)). The case law is clearly concerned with preventing an inventor from establishing conception through that inventor's "mere allegations" or "unsupported testimony where there has been no disclosure to others or embodiment of the invention in some clearly perceptible form…." Price v. Symsek, 988 F.2d 1187, 1194 (Fed. Cir. 1993) (internal citations omitted). In this case, there has been a disclosure and an embodiment in a clearly perceptible form witnessed by both Steve and Mike Koerner.

As discussed above, the corroboration requirement is "a flexible, rule-of-reason demand for independent evidence that, as a whole, makes credible the testimony of the purported prior inventor with regard to conception and reduction to practice of the invention as claimed." Fleming v. Escort Inc., No. 2014-1331, 2014-1371, 2014 U.S. App. LEXIS 24419 at *12 (December 24, 2014) (citing Sandt Tech, Ltd. v. Resco Metal & Plastics Corp., 264 F.3d 1344, 1350-51 (Fed.

Cir. 2001)). "Importantly, the law does not impose an impossible standard of independence to corroborative evidence…." Fleming, 2014 U.S. App. LEXIS 24419 at *10.

Independent evidence was offered in this case in the form of (1) documents uncovered from Mr. Koerner's workspace; (2) the business records of Mr. Freilich; (3) the business records of Bernina; and (4) independent statements and declarations of witnesses (i.e., Mrs. Koerner, Steve Koerner, Mike Koerner, Maria Shetler) who personally perceived certain events pertinent to Mr. Koerner's invention. The fact that Mr. Koerner was interested in obtaining documentation from these witnesses does not make their personal accounts any less independent or any less credible as the Board suggests. For at least these reasons, the Board misconstrued the independent nature of the corroborating evidence.

III. The Board Erred in Determining that Watabe is Applicable Prior Art Under 35 U.S.C. § 102(a)

The Board's failure to recognize the Patent Owner's evidence as sufficient to establish conception prior to Watabe's publication led to the error that Watabe is applicable prior art under 35 U.S.C. § 102(a). To predate a prior art reference, an inventor need only show conception and reasonable diligence to reduce the invention to practice. See Griffith v. Kanamaru, 816 F.2d 624, 626 (Fed. Cir. 1987). Because the evidence is sufficient to show prior conception and that Mr.

Koerner exercised reasonable diligence to reduce the invention to practice, Watabe is not applicable prior art under 35 U.S.C. §102(a).

IV. The Board Erred in Determining that Claims 1, 2, 5-7, 10, 12, 13, 17-21, 23-29, 31, 33, and 34 of the '446 Patent are Unpatentable Under 35 U.S.C. § 102(a)

The Board erred in determining that claims 1, 2, 5-7, 10, 12, 13, 17-21, 23-29, 31, 33, and 34 of U.S. Patent No. 6,883,446 are unpatentable under 35 U.S.C. § 102(a) because Watabe is not applicable as a prior art reference.

V. The Board Erred in Determining that Claims 1, 2, 5-7, and 23-27 of the '446 Patent are Unpatentable Under 35 U.S.C. § 103(a).

The Board erred in determine that claims 1, 2, 5-7, and 23-27 of the '446 Patent are unpatentable under 35 U.S.C. § 103(a) because Watabe is not applicable as a prior art reference. Reed does not resolve the deficiencies of Watabe and was not offered by Petitioner or the Board as a reference that could stand alone to render claims 1, 2, 5-7, and 23-27 of the '446 Patent unpatentable.

CONCLUSION

For the reasons set forth above, Bernina respectfully requests this Court:

(1) Reverse the Board's legal conclusion that the claims of the '446 Patent are not entitled to a priority date earlier than Watabe;

(2) Reverse the Board's legal conclusion that Watabe is applicable prior art;

(3) Reverse the Boards factual conclusion that claims 1, 2, 5-7, 10, 12, 13, 17-21, 23-29, 31, 33, and 34 are unpatentable under § 102 in view of Watabe; and

(4) Reverse the Board's legal conclusion that claims 1, 2, 5-7, and 23-27 of the '446 Patent are unpatentable under 35 U.S.C. § 103(a) in view of the combination of Watabe and Reed.

Dated: February 9, 2015

Respectfully submitted,

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CERTIFICATE OF SERVICE

I, Anthony S. Volpe, counsel for Bernina, hereby certify that on this 9th day of February, 2015, the foregoing **OPENING BRIEF OF APPELLANT, BERNINA INTERNATIONAL AG** was filed electronically with the U.S. Court of Appeals for the Federal Circuit by means of the Court's CM/ECF system. I further certify that the foregoing was served on the following counsel of record, by means of electronic mail to:

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CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITATION, TYPEFACE REQUIREMENTS, AND TYPE STYLE REQUIREMENTS

1. This brief complies with the type-volume limitation of Federal Rule of Appellate Procedure 32(a)(7)(B) because the brief contains 11,803 words, excluding those parts of the brief that are exempted by Federal Rule of Appellate Procedure 32(a)(7)(B)(iii).

2. This brief complies with the typeface requirements of Federal Rule of Appellate Procedure 32(a)(5) and the type style requirements of Federal Rule of Appellate Procedure 32(a)(6) because this brief has been prepared in proportionally spaced typeface using Microsoft Word in 14-point Times New Roman font.

Dated: February 9, 2015

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ADDENDUM

1. September 25, 2014 Decision of the United States Patent and Trademark Office Patent Trial and Appeal Board in *Inter Partes* Review No. IPR2013-00364

2. U.S. Patent No. 6,883,446 B2

Trials@uspto.gov
571-272-7822

Paper 39
Date: September 25, 2014

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HANDI QUILTER, INC. and TACONY CORPORATION,
Petitioners,

v.

BERNINA INTERNATIONAL AG,
Patent Owner.

Case IPR2013-00364
Patent 6,883,446 B2

Before JENNIFER S. BISK, MICHAEL J. FITZPATRICK, and GEORGIANNA W. BRADEN, *Administrative Patent Judges*.

FITZPATRICK, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318 and 37 C.F.R. § 42.73

I. BACKGROUND

Handi Quilter, Inc. and Tacony Corporation (collectively, "Petitioner") filed a Petition for an *inter partes* review of claims 1–34 of U.S. Patent No. 6,883,446 B2 ("the '446 patent"). Paper 1, "Pet." The Patent Owner, Berina International AG, filed a Preliminary Response pursuant to 35 U.S.C. § 313. Paper 9, "Prelim. Resp." In a November 5, 2013, Decision ("Institution Decision"), we granted the Petition and instituted trial on a subset of the claims on the following grounds:

claims 1, 2, 5–7, 10, 12, 13, 17–21, 23–29, 31, 33, and 34 as anticipated by Watabe;[1] and

claims 1, 2, 5–7, and 23–27 as obvious over Watabe and Reed.[2]

Paper 12 ("Dec."), 26.

After institution, Patent Owner filed a Patent Owner Response (Paper 17, "PO Resp."), and Petitioner filed a Reply (Paper 22, "Pet. Reply"). Petitioner filed a Motion to Exclude (Paper 20) certain evidence relied upon by Patent Owner in its Response.

Oral hearing was held on June 25, 2014.[3]

The Board has jurisdiction under 35 U.S.C. § 6(c). This final written Decision, issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73, addresses

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[1] Japanese Published Patent Application No. 2002/292175 (Oct. 8, 2002). Petitioner submitted the Japanese language reference (Ex. 1006) as well as a translation (Ex. 1004).
[2] U.S. Patent No. 4,192,241, issued Mar. 11, 1980 (Ex. 1009).
[3] A transcript of the oral hearing is included in the record. Paper 38.

issues and arguments raised during the trial.

As discussed below, Petitioner has shown by a preponderance of the evidence that claims 1, 2, 5–7, 10, 12, 13, 17–21, 23–29, 31, 33, and 34 of the '446 patent are unpatentable. Petitioner's Motion to Exclude is dismissed as moot.

A. Related Proceedings

Patent Owner asserted the '446 patent in separate lawsuits against each of the petitioners as follows: *Bernina International AG v. Handi Quilter, Inc.*, Case No. 2:12-cv-07079-JD (E.D. Pa.), and *Bernina International AG v. Tacony Corp.*, Case No. 2:13-cv-01787-JD (E.D. Pa.). Pet. 1; Paper 8, 1–2.

B. The '446 Patent

The '446 patent relates "to a method and apparatus for stitching together two or more fabric layers, as in quilting." Ex. 1001, 1:11–12. "A general goal of the quilting process is to produce precise consistent stitches that are closely and uniformly spaced." *Id*. at 1:31–33. Both parties agree the prior art included the use of a large frame that helps a user to produce consistent stitches. Pet. 12; Prelim Resp. 22; *see also* Ex. 1001, 1:65–67 (describing prior art use of "a frame and a quilting/sewing machine").

The '446 patent employs a motion detector to detect movement of the fabric stack in order to synchronize automatically the delivery of stitch strokes with the user's movement of the stack. *Id*. at 2:20–26. Figure 2 of the '446 patent is reproduced below.

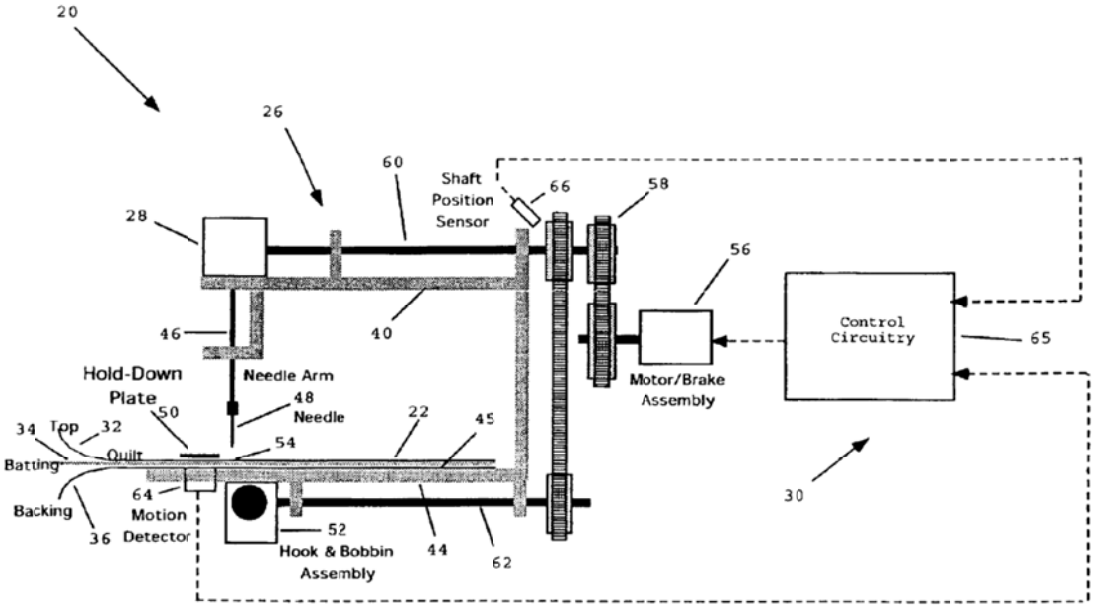


Figure 2 illustrates preferred embodiment 20 of a quilting system for stitching together fabric layers of stack 22. Ex. 1001, 4:14–16. The system comprises mechanical machine portion 26 that includes actuatable stitch head 28 including needle bar 46 supporting needle 48. *Id*. at 4:16–18, 4:29–31. The system also includes electronic control subsystem 30 for actuating the stitch head in response to movement of the stack. *Id*. at 4:18–20.

II. ANALYSIS

Claims 1, 2, 5–7, 10, 12, 13, 17–21, 23–29, 31, 33, and 34 of the ’446 patent (the “instituted claims”) are the subject of this *inter partes* review. Of those, claims 1, 10, 21, 23, 28, and 31 are independent. Claim 1 is illustrative and is reproduced as follows:

> 1. An apparatus for stitching together two or more stacked planar layers, said apparatus including:
>
> a stitch head mounted at a fixed location and actuatable to insert a stitch through a stack of two or more planar layers located beneath said stitch head;
>
> a substantially horizontally oriented bed for supporting said stack of planar layers for manually guided movement across said bed beneath said stitch head;
>
> detector means for detecting movement of a surface of said stack oriented parallel to said bed and proximate to said stitch head for producing signals representing the magnitude of stack surface movement; and
>
> control circuit means responsive to said signals indicating stack surface movement exceeding a certain threshold for actuating said stitch head to insert a stitch through said stack.

A. Claim Construction

In our Institution Decision, we expressly construed several claim terms. Dec. 6–15. Neither party disputes those constructions. *See* PO Resp. 3 ("Patent Owner does not agree with the Board's preliminary claim construction, but accepts it for the purposes of this response."); *see generally* Pet. Reply. We adopt those constructions in this final Decision.

B. Watabe as Prior Art

Both grounds instituted for *inter partes* review rely on Watabe, but Patent Owner contends that Watabe is not prior art to the instituted claims of the '446

patent. PO Resp. 4–23. Indeed, that is the main focus of Patent Owner's Response. *Id.*

1. Watabe as Prior Art Under 35 U.S.C. § 102(b)

Watabe was published on October 8, 2002. Ex. 1004, 1. The '446 patent issued from an application filed on February 11, 2004, but claims priority to provisional application no. 60/447,159 (Ex. 1013), which was filed February 12, 2003. Ex. 1001, 1:4–5. Thus, Watabe potentially is prior art to the instituted claims under either 35 U.S.C. § 102(a) or (b) (2002).[4] Petitioner, however, asserted Watabe as prior art under only § 102(a). *See* Pet. 3–4.

Petitioner purported to "reserve[] the right" to assert Watabe as prior art also under § 102(b). *Id*. at 4. A petition for an *inter partes* review, however, must identify "[t]he specific statutory grounds under 35 U.S.C. 102 or 103 on which the challenge to the claim is based." 37 C.F.R. § 42.104(b)(2). Further, a petition also must show how the challenged claims are unpatentable under each identified statutory ground. 37 C.F.R. § 42.104(b)(4). As part of that showing, a petition needs to show that a relied-upon reference qualifies as prior art under the identified

[4] The America Invents Act ("AIA"), Pub.L. No. 112–29, took effect on March 18, 2013. Because the application from which the '446 patent issued was filed before that date, our citations to 35 U.S.C. § 102 are to its pre-AIA version. The same is true of our citations below to 35 U.S.C. § 112.

statutory ground(s). *Id*. The Petition in this proceeding does not show, let alone assert, that Watabe is prior art to the instituted claims under 35 U.S.C. § 102(b).[5]

2. Watabe as Prior Art Under 35 U.S.C. § 102(a)

As discussed above, Petitioner contends that Watabe is prior art to the instituted claims under 35 U.S.C. § 102(a). Pet 3–4. That subsection provides: "A person shall be entitled to a patent unless– (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent." 35 U.S.C. § 102(a). Patent Owner argues that Watabe is not § 102(a)-prior art because the named inventor of the '446 patent, Ralph J. Koerner, invented the subject matter of the instituted claims before Watabe was published on October 8, 2002. PO Resp. 5; *see Mahurkar v. C.R. Bard, Inc.*, 79 F.3d 1572, 1576 (Fed. Cir. 1996) ("Thus, under section 102(a), a document is prior art only when published before the invention date.").

---

[5] We do not presume challenged claims are entitled, under 35 U.S.C. § 120, to the benefit of an earlier filing date of a priority application that does not share the same disclosure as the application from which the claims issued. But, in such circumstances, the issue has to be raised by a petitioner in its petition, by identifying the claims (including their specific limitations) allegedly lacking 35 U.S.C. § 112, first paragraph, written description and enabling disclosure in the priority application. Only then, would a patent owner have to make a sufficient showing of entitlement to the earlier filing date, in a manner that is commensurate in scope with the specific points and contentions raised by the petitioner. *See Polaris Wireless, Inc. v. Trueposition, Inc.*, No. IPR2013-00323, 2013 WL 8563953, at *17 (PTAB Nov. 15, 2013).

To show prior invention, Patent Owner must show that either (1) Mr. Koerner reduced his invention to practice before October 8, 2002, or (2) he conceived of the invention before October 8, 2002, and exercised reasonable diligence in reducing that invention to practice. *See Teva Pharm. Indus. Ltd. v. AstraZeneca Pharms. LP*, 661 F.3d 1378, 1383 (Fed. Cir. 2011). Patent Owner argues the latter. PO Resp. 5. Thus, Patent Owner must prove both prior conception and reasonable diligence. *Teva*, 661 F.3d at 1383.

With respect to the first prong, the Court of Appeals for the Federal Circuit has held:

> Conception is the touchstone of inventorship, the completion of the mental part of invention. *Sewall v. Walters*, 21 F.3d 411, 415 (Fed. Cir. 1994). It is "the formation in the mind of the inventor, of a definite and permanent idea of the complete and operative invention, as it is hereafter to be applied in practice." *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1376 (Fed. Cir. 1986) (citation omitted). Conception is complete only when the idea is so clearly defined in the inventor's mind that only ordinary skill would be necessary to reduce the invention to practice, without extensive research or experimentation. *Sewall*, 21 F.3d at 415; *see also Coleman v. Dines*, 754 F.2d 353, 359 (Fed. Cir. 1985) (conception must include every feature of claimed invention). Because it is a mental act, courts require corroborating evidence of a contemporaneous disclosure that would enable one skilled in the art to make the invention. *Coleman v. Dines*, 754 F.2d at 359.

Burroughs Wellcome Co. v. Barr Labs., Inc., 40 F.3d 1223, 1228 (Fed. Cir. 1994) (parallel citations omitted). Although it is based on underlying facts, conception is a question of law. *Price v. Symsek*, 988 F.2d 1187, 1190 (Fed. Cir. 1993); *Hybritech*, 802 F.2d at 1376.

The ’446 patent issued on April 26, 2005. Ex. 1001. Mr. Koerner, the named inventor, died in October 2012. Ex. 2002 ¶ 2; Ex. 2015 ¶ 3. He was informed, however, of the existence of Watabe in 2008 by his patent attorney and personal friend, Art Freilich. Ex. 2015 ¶¶ 3, 9. More specifically, Mr. Freilich learned of Watabe’s existence around September or October 2008, and thereafter discussed it with Mr. Koerner and asked him to “investigate his records and develop a timeline of the events surrounding his invention” as claimed in the ’446 patent. *Id*. at ¶¶ 9–10. As a result of that investigation, Mr. Koerner allegedly found four documents that bear dates prior to the publication of Watabe on October 8, 2002. *Id*. at ¶¶ 11, 15.

Mr. Koerner did not execute an affidavit or declaration, but, according to Mr. Freilich, he did prepare an April 16, 2009-dated document titled “Free Motion Switch Regulator Invention Timeline” (Ex. 2032), and, with the help of Mr. Freilich, a May 4, 2009-dated letter to the licensee of the ’446 patent, “Bernina/Fritz Gegauf AG,” discussing conception and diligence of the invention (Ex. 2033). Ex. 2015 ¶¶ 12–13.

The four documents that bear dates prior to October 8, 2002, are Exhibits 2003–2006. *See* PO Resp. 6; *see also id*. at 8 (citing Exs. 2039, 2029, 2030, and 2038, which, respectively, are copies of the same documents constituting

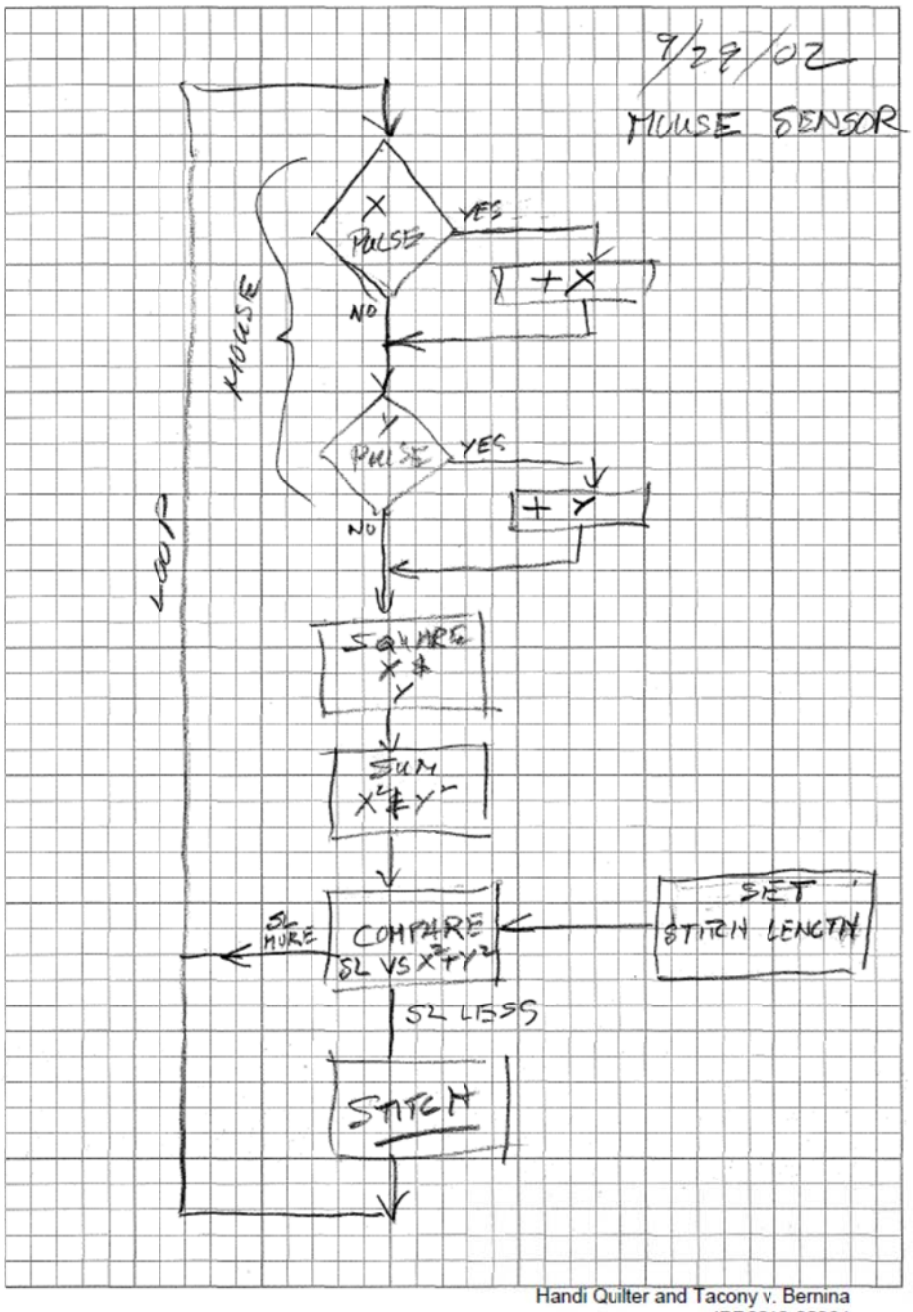
Exs. 2003–2006).[6] Patent Owner relies on three of these documents, Exhibits 2004–2006, to establish conception prior to October 8, 2002, by mapping them to "representative apparatus claims, 1, 10, and 21." PO Resp. 13. The documents, however, fail to show conception of the claimed inventions.

Claim 1 requires a "control circuit means responsive to said signals indicating stack surface movement exceeding a certain threshold for actuating said stitch head to insert a stitch through said stack." Claim 10 requires "control circuitry responsive to detected movement of said fabric layer surface for controlling actuation of said needle arm." Claim 21 requires "control means responsive to a translational movement of said stack of a magnitude exceeding a certain threshold for causing said needle to execute said cyclic movement." These are key limitations of the independent claims that are directed to the allegedly novel integration of prior art-motion detectors with prior art-apparatuses for stitching, sewing, or quilting.

To show conception for these limitations, Patent Owner relies on Exhibit 2006. *See* PO Resp. 16, 19, 23. Exhibit 2006 bears a date of September 29, 2002. Ex. 2006. Mrs. Koerner testified that she recognizes the document to be in her husband's handwriting. Ex. 2002 ¶ 15; *see also* Ex. 2015 ¶ 15 (Mr. Freilich

[6] Exhibits 2003-2006 are copies of the documents as collected by Mr. Koerner's widow sometime after his death (*see* Ex. 2002 (Declaration of Dorothy Koerner) ¶¶ 12–15), whereas Exhibits 2039, 2029, 2030, and 2038 are copies of the same documents as sent by Mr. Koerner to Mr. Freilich in 2009. *See* Ex. 2015 ¶¶ 11, 15. Patent Owner should not have filed duplicate documents. *See* 37 C.F.R. § 42.6(d).

testifying that he received a copy of this document from the inventor via email in 2009). Exhibit 2006 is reproduced below.



Handi Quilter and Tacony v. Bernina
IPR2013-00364
Bernina Exhibit 2006

Exhibit 2006 illustrates, in flow diagram format, a basic algorithm in which x and y pulses are inputted to a "mouse" or "mouse sensor,"[7] calculations are made based on those x and y pulses, and a comparison is made to a "set stitch length" to decide whether to stitch. Ex. 2006. The document does not show conception of how to control a sewing machine's stitch head or needle arm so that it actuates in response to detected movement. Further, Patent Owner has not presented evidence that mere ordinary skill in the art would have been required to reduce to practice the invention, as ultimately claimed, which requires controlling the stitch head or needle arm so that it actuates in response to detected movement. *See Burroughs*, 40 F.3d at 1228 ("Conception is complete only when the idea is so clearly defined in the inventor's mind that only ordinary skill would be necessary to reduce the invention to practice, without extensive research or experimentation."). Patent Owner has not presented sufficient evidence that the inventor had "a definite and permanent idea of the complete and operative invention," prior to October 8, 2002. *See, e.g.*, *Hybritech*, 802 F.2d at 1376. In fact, Mr. Koerner stated that it wasn't until November 25, 2002, that he "[s]ettled on control circuit for prototype machine." Ex. 2032; *see Burroughs*, 40 F.3d at 1228 ("An idea is definite and permanent when the inventor has a specific, settled idea, a particular solution to the problem at hand, not just a general goal or research plan he hopes to pursue.").

[7] Based on another submission in the record, it appears that "mouse" or "mouse sensor" refers to a computer mouse, which, of course, detects its own movement across a surface, but which Mr. Koerner stated in 2009 he had turned upside down so that it was "arranged to 'look up' at a fabric surface." *See* Ex. 2033 ¶ 5.

In addition to finding the content of the purported evidence insufficient, we are not satisfied that the evidence is reliable. First, Patent Owner has not persuaded us that the document (Ex. 2006) was created on the date that it bears, September 29, 2002. It may have been, but perhaps not. The record lacks inventor testimony. We have only an unsworn statement from the inventor that was made years later. *See* Ex. 2033 (letter dated May 4, 2009 from Mr. Koerner to Bernina/Fritz Gegauf AG); *see also Price*, 988 F.2d at 1195 n.3 ("Factors bearing on the inventor's credibility . . . are: (1) delay between the event and the trial . . . ."). Also, in his statement, Mr. Koerner does not state that he prepared the document on September 29, 2002. He says he prepared it "on or before September 29, 2002." Ex. 2033 ¶ 5. Thus, according to Mr. Koerner, the date appearing on his document was not necessarily the date the document was created or last-modified.[8]

The record lacks any evidence, apart from Mr. Koerner, that this document existed on (or before) September 29, 2002. *See Burroughs*, 40 F.3d at 1228 ("[T]he inventor must prove his conception by corroborating evidence, preferably

[8] Another document relied on to show conception with respect to other limitations of the claims bears a type-written date of September 20, 2002. Ex. 2005. Yet, Patent Owner concedes that it (i.e., Exhibit 2005) was modified after September 20, 2002. *See* PO Resp. 12 (citing Ex. 2031). Patent Owner contends Exhibit 2005 was last modified on October 4, 2002, but does not present persuasive evidence to support the contention. *See* PO Resp. 12 (citing Ex. 2031). Regardless of when Exhibit 2005 was last modified, this example demonstrates that a date appearing on a document is not necessarily the date on which the document was created or last-modified.

by showing a contemporaneous disclosure."). As explained by the Federal Circuit in *Mahurkar*, the requirement for corroborating evidence arose out of concern that inventors would be tempted to remember facts favorable to their case "by the lure of protecting their patent or defeating another's patent." 79 F.3d at 1577. Based on the record presented, it appears that the first time anyone other than Mr. Koerner saw this document was in 2009, during events that were precipitated by Mr. Frelich informing Mr. Koerner of Watabe's existence. Ex. 2015 ¶ 9–10. Thus, corroboration evidence is required.

Independent corroboration may consist of testimony of a witness, other than the inventor, or it may consist of evidence of surrounding facts and circumstances, independent of information received from the inventor. *Reese v. Hurst*, 661 F.2d 1222, 1225 (CCPA 1981); *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1170 (Fed. Cir. 2006) ("The requirement of independent knowledge remains key to the corroboration inquiry."). As Patent Owner recognizes, corroboration is determined under a "rule of reason" analysis. PO Resp. 4–5 (citing *Price*, 988 F.2d at 1195; *Berges v. Gottstein*, 618 F.2d 771, 776 (CCPA 1980)). "An evaluation of *all* pertinent evidence must be made so that a sound determination of the credibility of the inventor's story may be reached." *Price*, 988 F.2d at 1195. However, "[t]he rule of reason . . . does not dispense with the requirement for some evidence of independent corroboration." *Coleman*, 754 F.2d at 360.

Although Patent Owner does not present any evidence corroborating that Exhibit 2006 predates the publication of Watabe, it does present evidence purporting to corroborate other facts regarding conception. In particular, Patent Owner offers evidence from Mr. Koerner's widow, his sons, his patent attorney,

and a woman named Maria Shetler. The evidence, however, is insufficient on its face to show Mr. Koerner had, prior to October 8, 2002, "a definite and permanent idea of the complete and operative invention." *Hybritech*, 802 F.2d at 1376. Further, some of the evidence offered by Patent Owner is not sufficiently reliable.

In her declaration, Mrs. Koerner testifies that Mr. Koerner told her, in the spring of 2002, that he "conceived of a solution to the problem of achieving stitch uniformity while free motion quilting by detecting fabric movement and automatically controlling the stitch rate." Ex. 2002 ¶ 7. Regardless of whether this statement is being offered for the truth of the matter asserted by Mr. Koerner (i.e., that he conceived in spring of 2002), we do not give it weight in our conception analysis. Conception is a question of law based on underlying facts. *Price*, 988 F.2d at 1190; *Hybritech*, 802 F.2d at 1376. This statement, even if it were in the form testimony from Mr. Koerner himself, does not speak to any underlying facts. It is merely a legal conclusion that conception occurred.

Mrs. Koerner also testifies that, in the spring of 2002, Mr. Koerner demonstrated to her that he could use a mouse-like device to detect fabric motion. Ex. 2002 ¶ 7. This testimony relates to one aspect of the claimed inventions (e.g., the "detector means" of claim 1). It does not support a legal conclusion of conception of the complete and operative invention.

Mrs. Koerner further testifies that, several months later, her husband "demonstrated a model he built for detecting fabric movement to provide signals for controlling the stitching rate to our sons, Steve and Mike." *Id*. at ¶ 9. We do not give weight to this testimony, because it lacks a foundation, as she does not testify to witnessing the demonstration.

Her sons are alive and could have offered testimony in support of the Patent Owner Response. They did not. The Patent Owner Response relies instead upon unsworn statements by Steve and Mike Koerner from 2009. Exs. 2034–2035. These statements are not reliable corroboration evidence. Mr. Freilich testifies that these statements were "signed by" the sons but not prepared by them. Ex. 2015 ¶ 14. Mr. Freilich testifies that the sons' statements were prepared instead by Mr. Koerner with Mr. Freilich's assistance, after Mr. Freilich telephoned the sons to "confirm their recollections." *Id*. We do not find the sons' statements, which were prepared by the inventor and his attorney, to be sufficiently independent from the inventor for purposes of corroboration. *See Reese*, 661 F.2d at 1225 ("evidence of corroboration must not depend solely on the inventor himself"); *Medichem*, 437 F.3d at 1170 ("The requirement of independent knowledge remains key to the corroboration inquiry.").

Even if independent testimony of the September demonstration from someone with first-hand knowledge of it had been offered, such testimony could not support a legal conclusion of conception of the claimed inventions, which requires not only the detection of fabric movement but also control means or circuitry for actuation of a machine's stitch head or needle in response to the detected movement. None of Mrs. Koerner's declaration (Ex. 2002), the sons' letters (Exs. 2034–2035), or even the sons' declarations (Exs. 2047–2048), which were submitted not in support of Patent Owner's Response but rather in response to Petitioner's evidentiary objections to the son's letters, purports to show controlling actuation of a machine's stitch head or needle arm in response to the detection of fabric movement.

Patent Owner also submitted an April 7, 2009-dated letter from Maria Shetler. Ex. 2013, 2. The letter is an unsworn statement by Ms. Shetler that, pursuant to an inquiry from Mrs. Koerner, Ms. Shetler gave Mr. Koerner an old sewing machine in July 2002 for him to experiment with in developing his invention. *Id*. This evidence may tend to prove the underlying fact that Mr. Koerner intended to work on a sewing machine invention in July of 2002 (or soon thereafter), but Patent Owner has not proven underlying facts sufficient to establish that Mr. Koerner had "a definite and permanent idea of the complete and operative invention," prior to October 8, 2002. *See*, *e.g.*, *Hybritech*, 802 F.2d at 1376.

We have considered and evaluated all of the pertinent evidence Patent Owner has offered to establish conception prior to the publication of Watabe. We determine that Patent Owner has failed to establish conception of the inventions set forth in the instituted claims prior to the publication of Watabe. Therefore, Watabe is prior art under 35 U.S.C. § 102(a).

C. Anticipation by Watabe

We instituted trial on the ground of claims 1, 2, 5–7, 10, 12, 13, 17–21, 23–29, 31, 33, and 34 as anticipated by Watabe. Dec. 26.

1. Disclosure of Watabe

Watabe discloses a sewing machine that comprises:

> distance measuring means for measuring, with each constant time interval, a distance by which a fabric is fed; pitch width setting means for setting a stitch pitch width; and needle speed changing means for setting a sewing needle operating speed for forming stitches

> corresponding to the pitch width based on the distance measured by the distance measuring means and the pitch width set by the pitch width setting means.

Ex. 1004 ¶ 6. In short, Watabe discloses a sewing machine that utilizes a motion detector to synchronize automatically the delivery of stitch strokes to the detected movement of the fabric being stitched. Figure 1 of Watabe is reproduced below.

[FIG. 1]

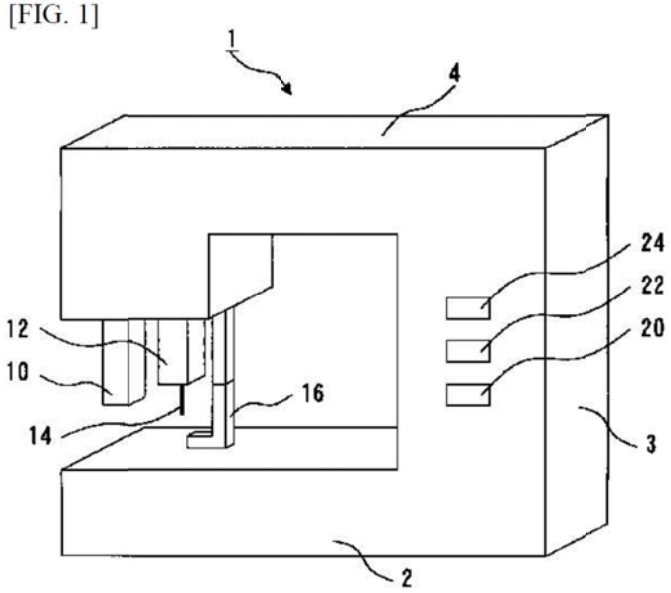


Figure 1 illustrates sewing machine 1 having bed portion 2, leg column portion 3, and arm portion 4. Ex. 1004 ¶ 10. The leg column portion is provided with switches 20, 22, and 24, for turning the sewing machine on, starting sewing, and setting a desired pitch width for the stiches. *Id*. at ¶ 11. The arm portion includes a "needle bar driving mechanism" having needle bar 12 supporting needle 14. *Id*. The arm portion also includes image sensor 10 that faces downward toward bed portion 2. *Id*.

Although not illustrated in Figure 1, the Watabe sewing machine also includes a motor for driving the stitch head and a circuit for controlling the motor.

Ex. 1004 ¶ 11. One revolution of the motor causes one revolution of the vertically reciprocating needle bar. *Id*. Thus, the speed of the motor is directly proportional to the speed of the needle bar driving mechanism. The Watabe sewing machine has a built-in microcomputer for controlling the motor based on the user-inputted pitch width and on the quantity of fabric movement detected by the image sensor. *Id*. at ¶¶ 7, 12.

When the Watabe sewing machine is turned on via switch 20, the microcomputer begins operating. Ex. 1004 ¶ 13. Thereafter, the microcomputer waits until sewing switch 22 is turned on. *Id*. at ¶ 14. Once that happens, the pitch width can be set via switch 24. *Id*. The microcomputer then actuates the motor, which causes the needle bar to start reciprocating continuously. *Id*. at ¶ 15. Initially, the motor revolves at a predetermined speed (e.g., 1 Hz) that is set in advance. *Id*.

Subsequently, the motor's speed is modified continuously in proportion to the speed of the fabric across the bed portion. As the fabric is moved across the bed portion, the amount of movement per interval of time is detected by the image sensor. Ex. 1004 ¶ 21. Using that information (and the pitch width), the microcomputer calculates a corresponding speed at which the motor should revolve. *Id*. The microcomputer then outputs to the circuit a control signal for changing the current speed of the motor to the newly calculated speed. *Id*. at ¶ 22. As a consequence, the Watabe sewing machine forms stitches in the fabric having the desired pitch width without the user having to change manually the speed of the needle (e.g., through pedals) as the speed of the fabric being moved across the bed portion changes. *Id*. at ¶ 26.

2. Comparison of Watabe to the Independent Claims

Claim 1 is exemplary of the independent claims (claims 1, 10, 21, 23, 28, and 31). It requires "a stitch head mounted at a fixed location and actuatable to insert a stitch through a stack of two or more planar layers located beneath said stitch head." In the Institution Decision, we found this feature met in Watabe by its needle bar driving mechanism having needle bar 12 supporting needle 14 extending down from the arm portion 4. Dec. 16 (citing Ex. 1004 ¶ 11; Fig. 1). Patent Owner argues that the record lacks evidence that Watabe's needle is *capable*[9] of "stitching through two or more planar layers," as recited by claim 1. PO Resp. 24.

We are not persuaded by Patent Owner's argument. Watabe discloses and illustrates a sewing machine (Ex. 1004, Fig. 1), and specifically discusses the mechanics of the needle during sewing. *Id*. at ¶ 11. A sewing machine needle inherently is capable of stitching through two layers, so as to sew them together.

Further, none of the claims limits the thickness or hardness of the layers (or fabric) to be stitched. Thus, if a sewing machine is capable of inserting a stitch into a single layer of a fabric material (which is beyond dispute), it necessarily is capable of inserting a stitch into two layers of that same material, if each layer is half as thick as the single layer.

[9] As set forth in the Institution Decision, claims 23–27 require actual insertion of a stitch head through multiple fabric layers, whereas claims 1, 2, and 5–7 require a stitch head that merely is capable of doing so. Dec. 20.

Claim 1 also requires "a substantially horizontally oriented bed for supporting said stack of planar layers for manually guided movement across said bed beneath said stitch head." This feature is met in Watabe by its "bed portion 2 that has a flat table portion." Ex. 1004 ¶ 10; Fig. 1.

Claim 1 also requires "detector means for detecting movement of a surface of said stack oriented parallel to said bed and proximate to said stitch head for producing signals representing the magnitude of stack surface movement."[10] This feature is met in Watabe by its "distance measuring means for measuring, with each constant time interval, a distance by which a fabric is fed." Ex. 1004 ¶ 6; *see also id*. at ¶ 7 ("the distance measuring means may be structured from an image sensor and a microcomputer").

Lastly, claim 1 requires "control circuit means responsive to said signals indicating stack surface movement exceeding a certain threshold for actuating said stitch head to insert a stitch through said stack."[11] This feature is met in Watabe, which states that the sewing machine includes a "needle speed changing means for

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[10] We have construed this limitation, pursuant to 35 U.S.C. § 112, sixth paragraph, as encompassing the detectors illustrated in Figures 8 and 12 and described in columns 5, 6, 9, and 10 of the '446 patent and equivalents. *See* Dec. 7. We noted, in particular, that Figures 8 and 12 illustrate optical motion detectors, although the text of the '446 patent is broader in that it states that a motion detector "can take many different forms, including both noncontacting devices (e.g., optical detector) and contacting devices (e.g., track ball)." *Id.* (quoting Ex. 1001, 5:43–45).

[11] We have construed this limitation, pursuant to 35 U.S.C. § 112, sixth paragraph, as encompassing the circuitry illustrated in Figures 9 and 13, any circuitry capable of carrying out the algorithms illustrated in Figures 10, 11, and 14, the circuitry described at columns 7 and 10, and equivalents. *See* Dec. 7–9.

setting a sewing needle operating speed for forming stitches corresponding to the pitch width based on the distance measured by the distance measuring means and the pitch width set by the pitch width setting means." Ex. 1004 ¶ 6; *see also id*. at ¶¶ 21-22.

Petitioner has shown by a preponderance of the evidence that Watabe anticipates independent claim 1. Independent claims 10, 21, 23, 28, and 31 are not materially different than claim 1 for purposes of comparison with Watabe. Petitioner also has shown by a preponderance of the evidence that Watabe anticipates claims 10, 21, 23, 28, and 31. *See* Pet. 37, 38, 41–47.

3. Comparison of Watabe to Dependent Claims

Dependent claims 2, 5–7, 12, 13, 17–20, 24–27, 29, 33, and 34 were included in the ground for review as anticipated by Watabe. Dec. 26. Petitioner has demonstrated by a preponderance of the evidence that Watabe discloses all additional features required by these claims. *See* Pet. 34–36, 38–40, 43–45, 47. As Patent Owner does not argue that Watabe fails to disclose any of these additional features, *see generally* PO Resp., we address in detail only a subset of the dependent claims.

Claim 2 depends from claim 1 and requires that the control circuit means additionally "includes means for applying power to said stitch head to cause said needle to traverse one cycle from said full up position to said full down position to said full up position." This feature is met by Watabe's "needle speed changing means," which can control the speed of a rotating sewing machine motor, which

motion is converted "into reciprocating motion in the vertical direction, so that the sewing needle operates in the vertical direction." Ex. 1004 ¶ 8; *see also id*. at ¶ 11.

Claim 5 depends from claim 1 and requires that the "bed defines a flat substantially horizontal surface for supporting said stack of planar layers" and that the "stitch head includes a needle mounted for movement substantially perpendicular to said bed surface between a full up position and a full down position whereat it pierces said planar layers supported on said bed surface." These features are met by Watabe, which discloses "bed portion 2 that has a flat table portion" that is oriented perpendicularly to the needle 14, which reciprocates in a vertical direction, and, therefore, perpendicular to the table portion. Ex. 1004 ¶¶ 10-11.

Claim 12 depends from claim 10 and requires that the "detector operates to detect movement of said fabric layer surface without physically contacting said fabric layer." This feature is met by Watabe's "image sensor 10," which operates through images and not physical contact. Ex. 1004 ¶ 11. Watabe describes it as "facing downward" but not as contacting anything. *Id*. Watabe depicts it being a significant distance above the table portion and, thus, not in a position to contact the fabric supported thereon. Ex. 1004, Fig. 1.

Claim 13 depends from claim 10 and requires "a window oriented to collect energy from said fabric layer surface oriented parallel to said plate; and signal processing means responsive to energy collected by said window for producing signals representing the magnitude of movement of said fabric layer across said plate." These features are met by Watabe. Neither party proposed a construction for "window," and the '446 patent describes it only by function, stating that is "to

collect reflected energy from target area coincident with the stack [fabric] surface." Ex. 1001, 2:41–44. We previously determined that an optical sensor, such as image sensor 10 of Watabe, must include a "window" because it necessarily detects light energy. *See* Dec. 11. Also, Patent Owner does not dispute that Watabe's image sensor inherently includes a window. *See generally* PO Resp. Watabe discloses that its image sensor detects varying amounts of movement per constant time interval and, through control signals, Watabe's needle speed changing means correspondingly changes the speed of the reciprocating needle. Ex. 1004 ¶¶ 6, 21, and 22.

Petitioner has demonstrated by a preponderance of the evidence that Watabe anticipates dependent claims 2, 5–7, 12, 13, 17–20, 24–27, 29, 33, and 34.

D. Obviousness over Watabe and Reed

We instituted review of claims 1, 2, 5–7, and 23–27 as being unpatentable as obvious over Watabe and Reed. Dec. 26.

Watabe refers to stitching of "fabric" without reference to the number of layers of fabric. Reed expressly teaches the stitching of multiple layers of fabric. Ex. 1009, Abstract (describing "quilting layered fabrics by a sewing machine"). Petitioner asserts that, to the extent claims 1, 2, 5–7, and 23–27 require multiple layers of fabric,[12] Watabe in view of Reed render them unpatentable. Pet. 31.

[12] Independent claim 23 (claims 24–27 being dependent thereon) requires actually "actuating said stitch head . . . to insert a stitch through said stack of fabric layers," whereas apparatus claim 1 (claims 2 and 5–7 being dependent thereon) recites a stitch head that is merely "actuatable to insert a stitch through a stack of two or

In asserting unpatentability over Watabe and Reed, Petitioner does not propose modifying the Watabe sewing machine in view of Reed. Rather, Petitioner relies on Reed for providing an express teaching to the person of ordinary skill in the art that the Watabe prior art-sewing machine can be used to stitch together multiple layers of fabric such as in quilting. Pet. 31.

Patent Owner argues against Petitioner's obviousness ground by asserting that Reed and Watabe "are not combinable" because "Reed is an older reference that teaches the use of a movable sewing machine and hand controls for stitching in 'free-hand quilting.'" PO Resp. 25. Patent Owner further states that "the Board's Decision recognizes that there is no effort to demonstrate that Reed's sewing machine is interchangeable with Watabe's sewing machine, and there is nothing in Watabe or Reed to suggest that they could be combinable." *Id*. at 26. Patent Owner's arguments are not responsive to Petitioner's application of Watabe and Reed to the claims. Petitioner does not argue for physically combining the Watabe and Reed prior art-machines or modifying either of them in view of the other. Petitioner relies on Reed for providing an express teaching to the person of ordinary skill in the art that the Watabe prior art-sewing machine can be used to stitch together multiple layers of fabric. Pet. 31. Petitioner's reasoning is persuasive, and it has demonstrated, by a preponderance of the evidence, that claims 1, 2, 5–7, and 23–27 would have been obvious over Watabe and Reed.

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more planar layers located beneath said stitch head." *See* Dec. 20 (quoting Ex. 1001, claims 23 and 1). Thus, a teaching of actually penetrating multiple layers is not required to meet claims 1, 2, and 5–7.

III. PETITIONER'S MOTION TO EXCLUDE

Petitioner moved to exclude some of the evidence relied upon by Patent Owner to support its arguments for prior invention. Paper 20. Resolution of Petitioner's motion is unnecessary to this final written Decision because, even considering the challenged evidence, Patent Owner's arguments for prior invention are not persuasive. Accordingly, we dismiss Petitioner's Motion to Exclude as moot.

IV. ORDER

Accordingly, it is

ORDERED that claims 1, 2, 5–7, 10, 12, 13, 17–21, 23–29, 31, 33, and 34 of U.S. Patent No. 6,883,446 B2 are held unpatentable;

FURTHER ORDERED that Petitioner's Motion to Exclude is dismissed; and

FURTHER ORDERED that, because this Decision is final, a party to the proceeding seeking judicial review of the Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

IPR2013-00364
Patent 6,883,446 B2

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US006883446B2

(12) **United States Patent**
Koerner

(10) **Patent No.: US 6,883,446 B2**
(45) **Date of Patent: Apr. 26, 2005**

(54) **QUILTING METHOD AND APPARATUS**

(76) Inventor: **Ralph J. Koerner**, P.O. Box 1320, Ramona, CA (US) 92065

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/776,355**

(22) Filed: **Feb. 11, 2004**

(65) **Prior Publication Data**

US 2005/0016428 A1 Jan. 27, 2005

Related U.S. Application Data

(60) Provisional application No. 60/447,159, filed on Feb. 12, 2003.

(51) **Int. Cl.**[7] **D05B 69/36**
(52) **U.S. Cl.** **112/272**; 112/475.02
(58) **Field of Search** 112/117, 271, 112/272, 274, 275, 475.02, 277, 470.03; 700/136, 130

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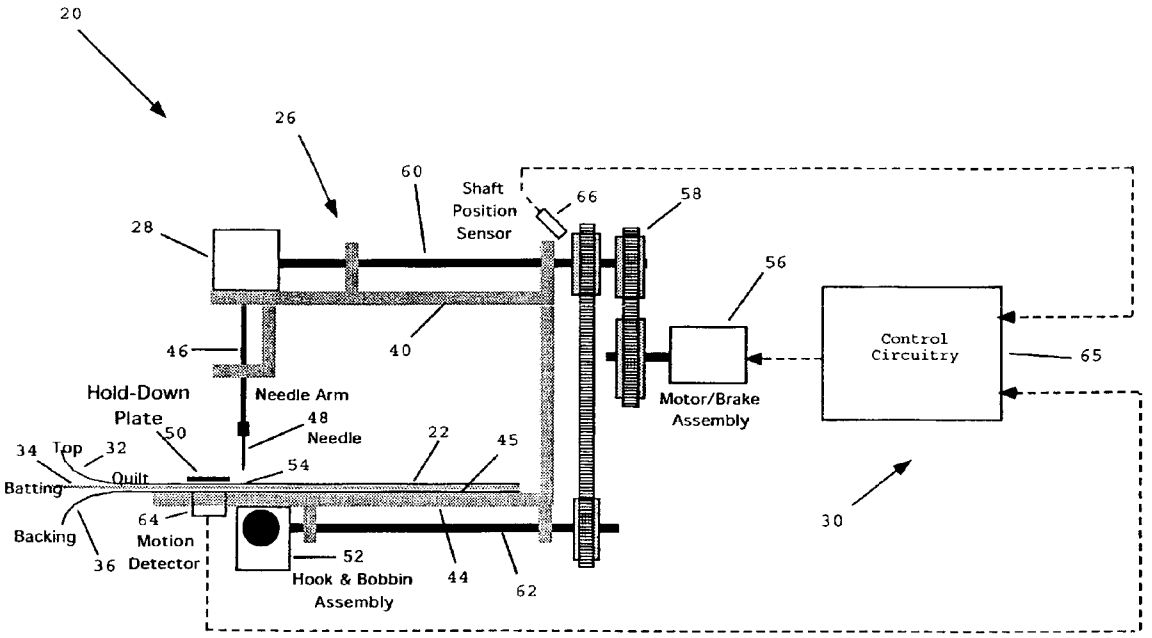
Primary Examiner—Rodney Lindsey
Assistant Examiner—Brian Kauffman
(74) *Attorney, Agent, or Firm*—Freilich, Hornbaker & Rosen

(57) **ABSTRACT**

A quilting apparatus for enabling a user to freely move a stack of fabric layers across a planar bed relative to an actuatable stitch head. The apparatus includes a motion detector which detects the movement of the stack and controls the actuation of the stitch head. Consequently, the apparatus functions to synchronize the delivery of stitch strokes by the head with the manually controlled movement of the quilt material stack. This frees the user to move the stack over a wide range of speeds, to start or stop movement at will, and to guide the stack in any direction across the planar bed.

34 Claims, 15 Drawing Sheets



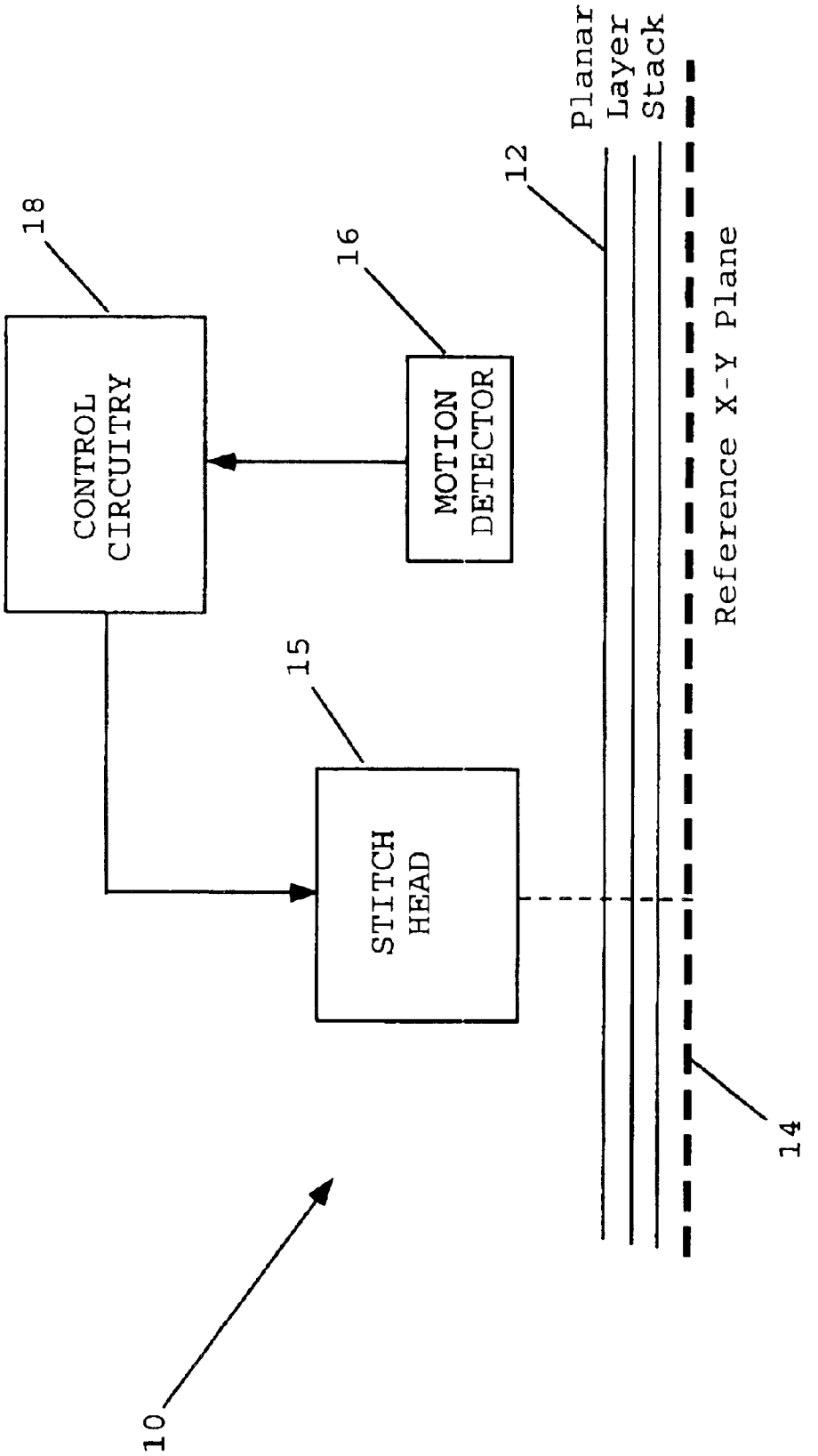

Planar Layer Stack
12
18
16
CONTROL CIRCUITRY
MOTION DETECTOR
15
STITCH HEAD
Reference X-Y Plane
14
10

FIGURE 1

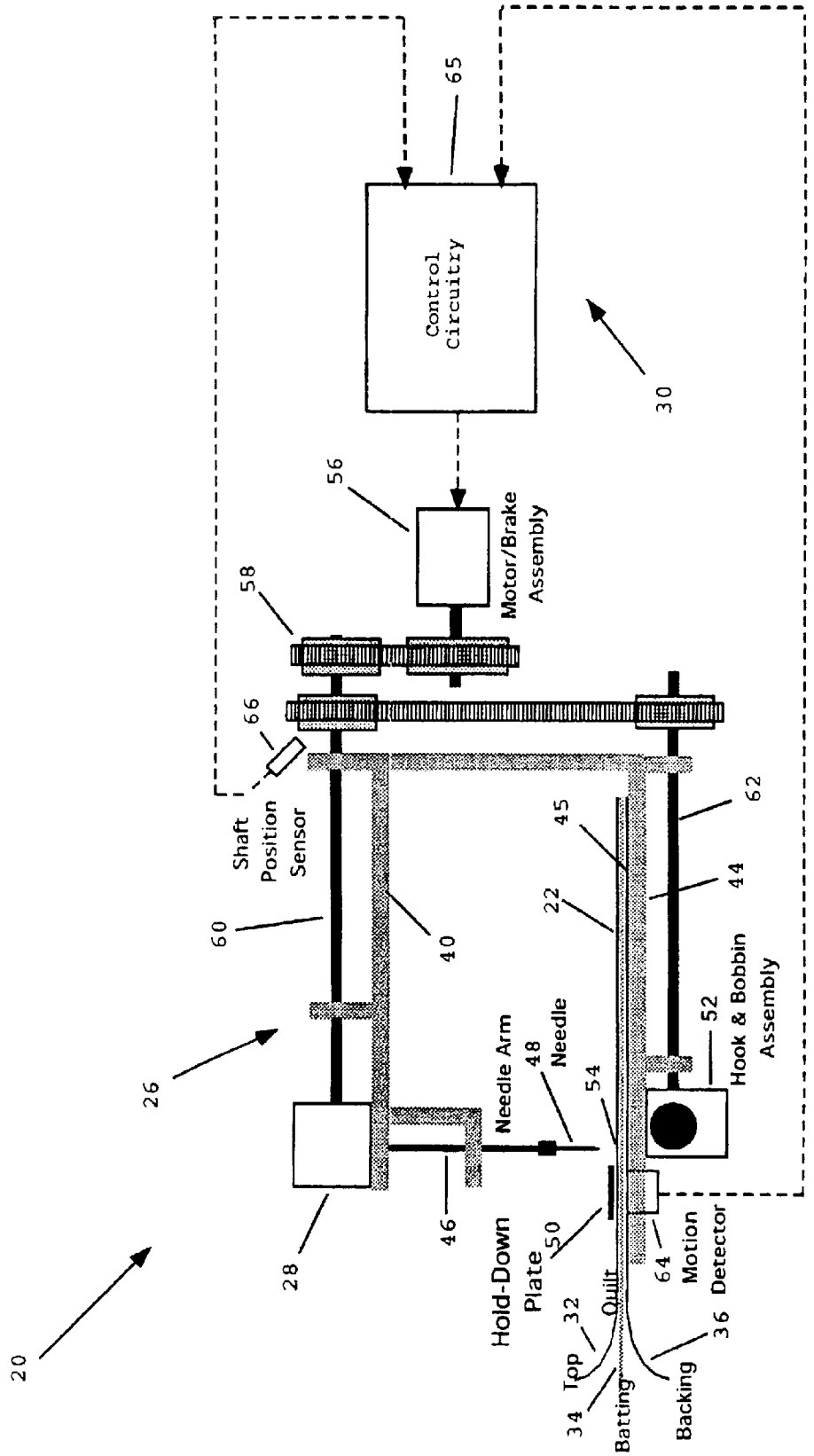

65
Control Circuitry
30
56
Motor/Brake Assembly
58
66
Shaft Position Sensor
60
40
62
45
44
22
52
Hook & Bobbin Assembly
26
Needle Arm
48
Needle
54
46
28
Hold-Down Plate
50
64
Motion Detector
36
32
Top
Quilt
34
Batting
Backing
20

FIGURE 2

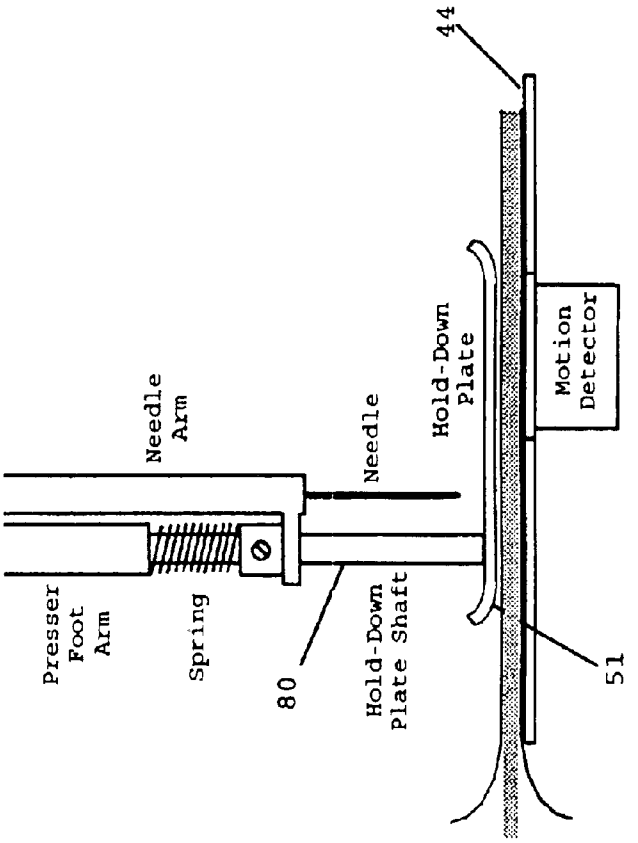


FIGURE 4

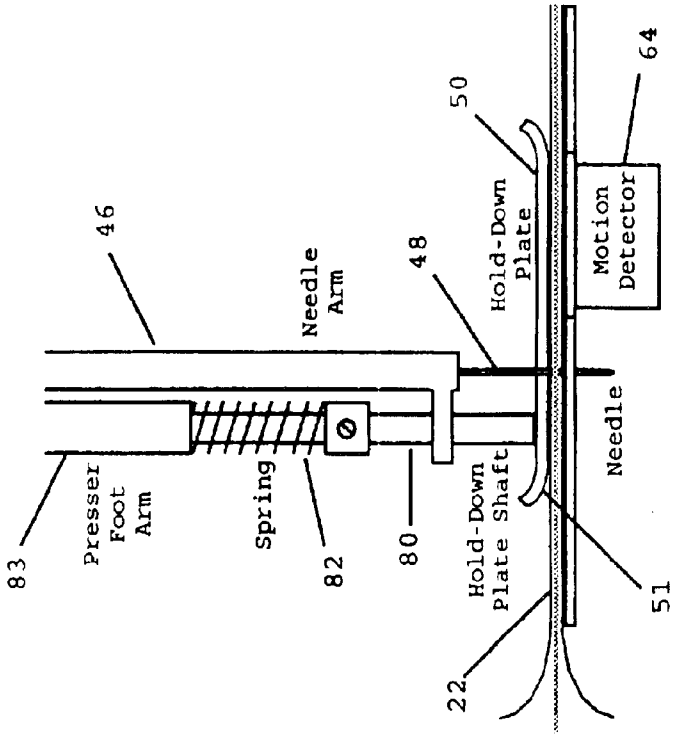


FIGURE 3

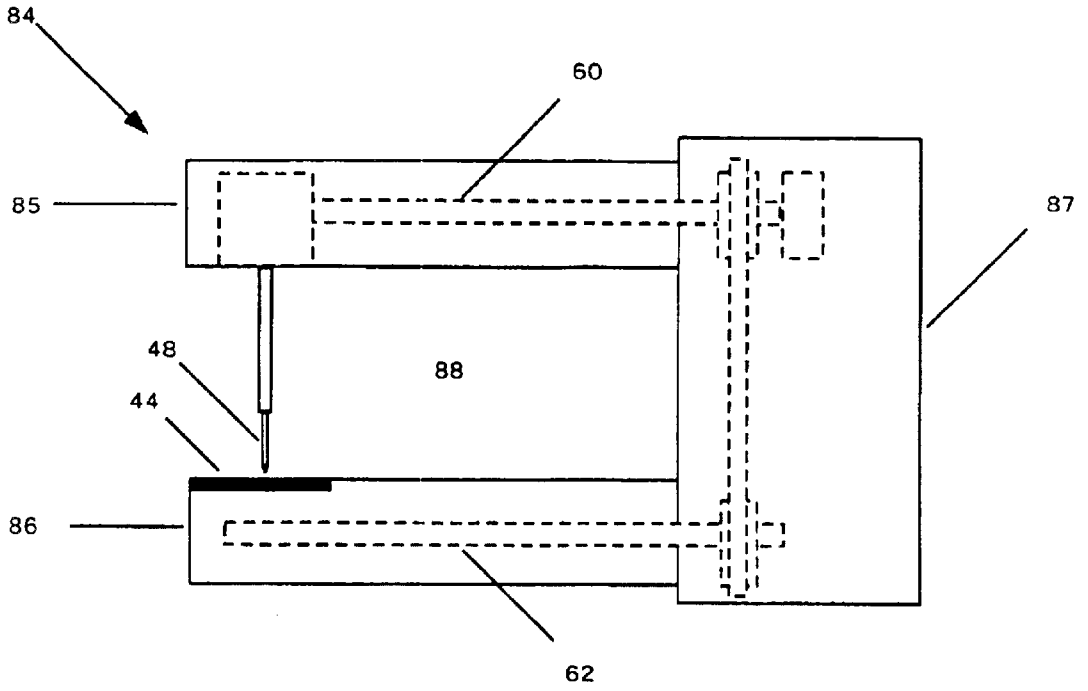


Figure 5

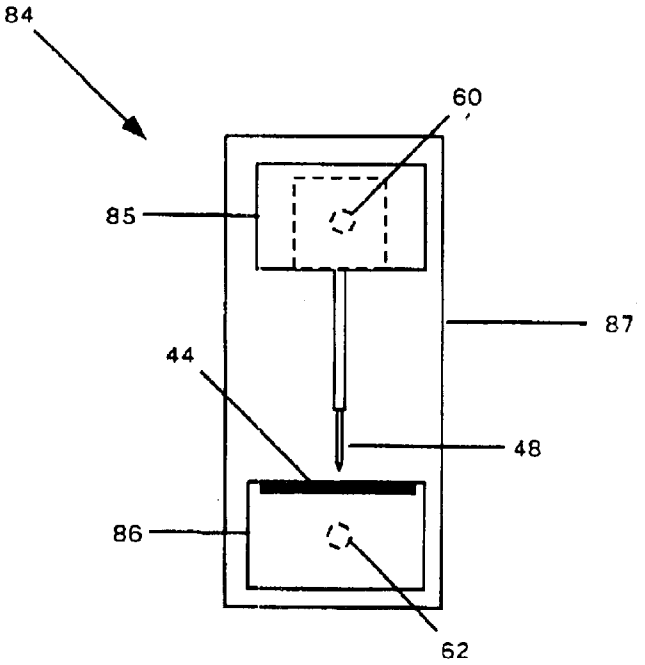


Figure 6

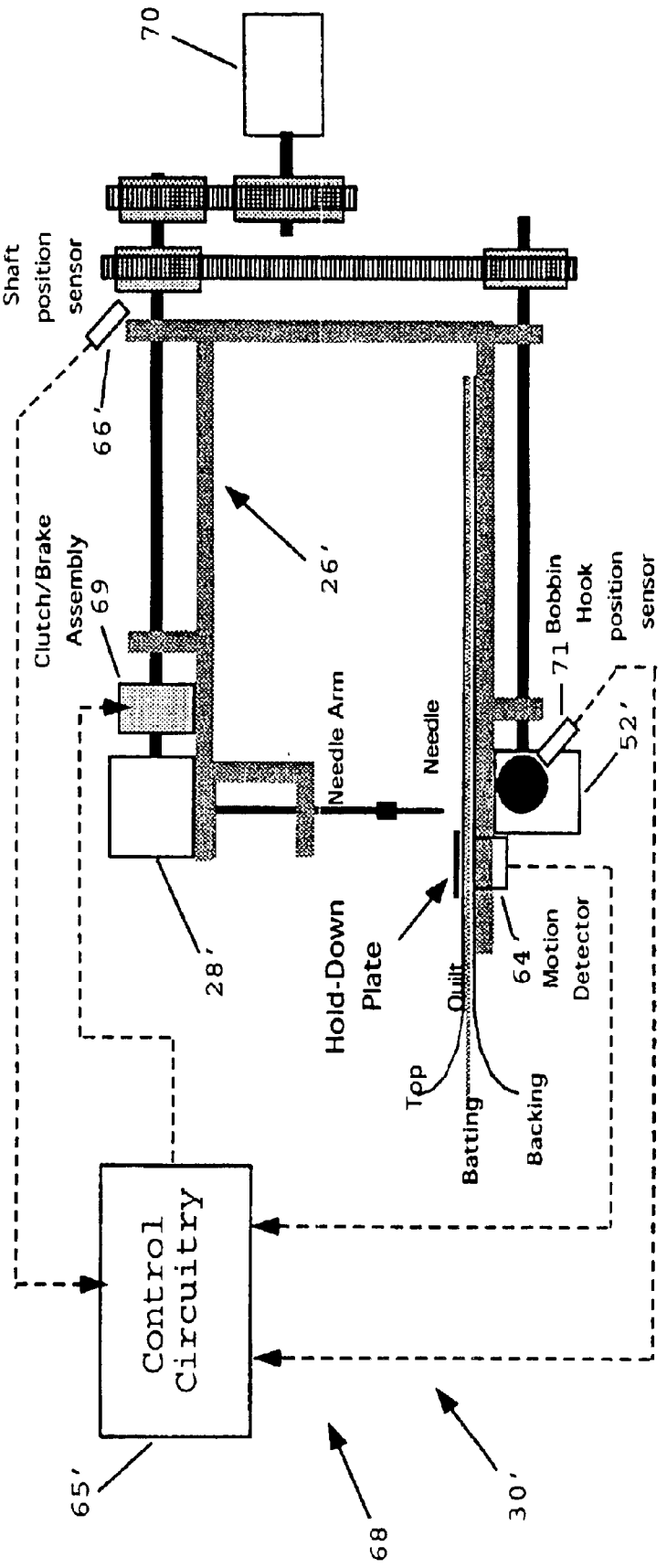

70
Shaft position sensor
66'
Clutch/Brake Assembly 69
26'
Bobbin Hook position sensor
71
Needle Arm
Needle
52'
28'
Hold-Down Plate
64
Motion Detector
Quilt
Top
Batting
Backing
Control Circuitry
65'
68
30'

FIGURE 7

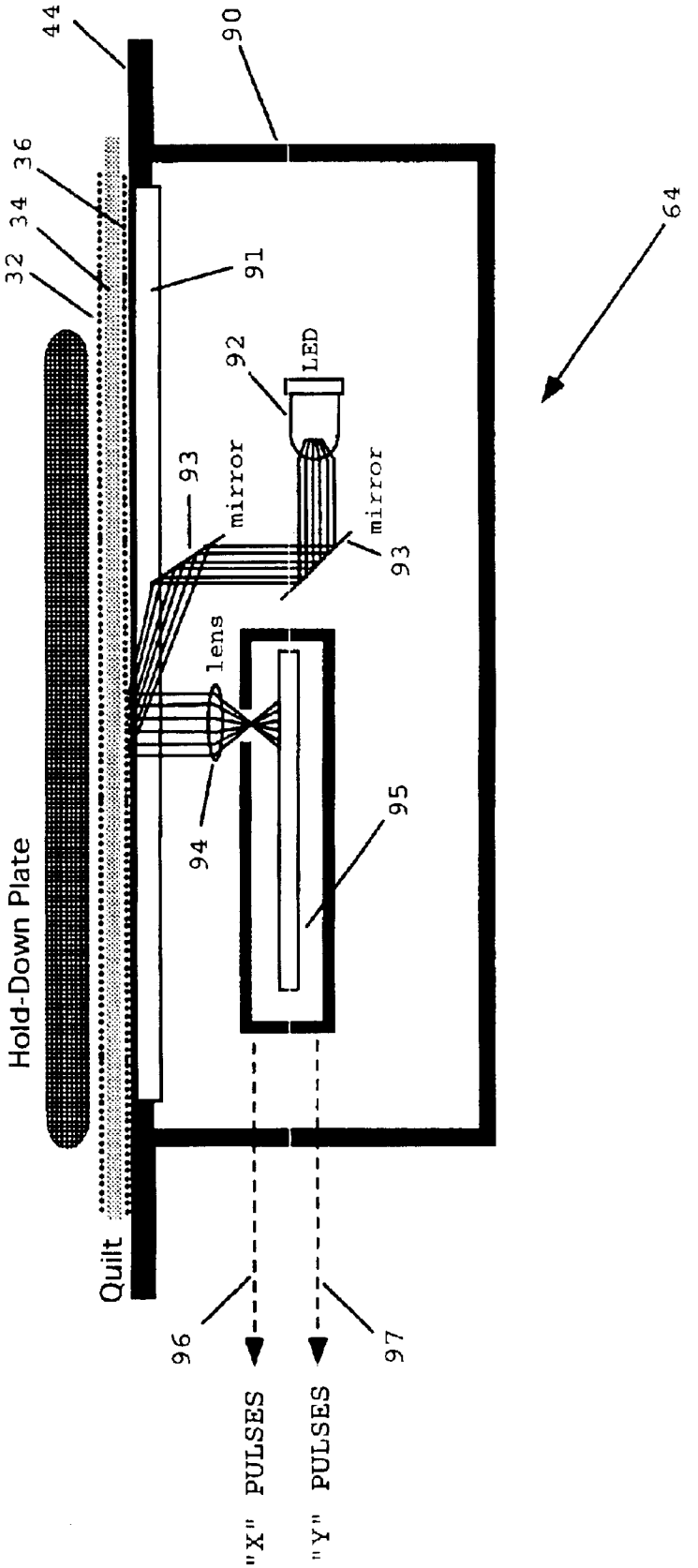

44
90
36
34
32
91
64
92
LED
93
mirror
mirror
93
lens
94
95
Hold-Down Plate
Quilt
96
97
"X" PULSES
"Y" PULSES

FIGURE 8

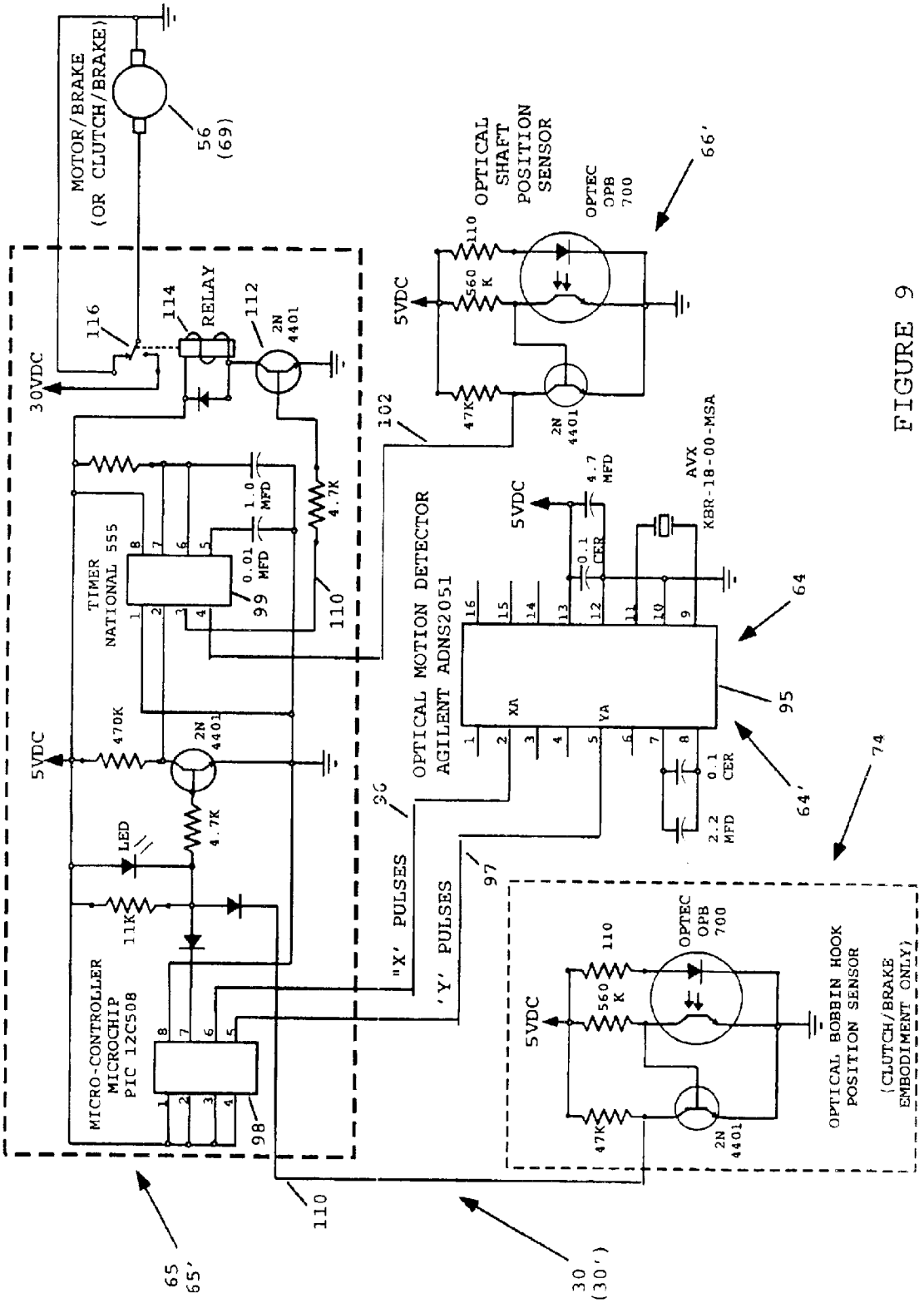

MOTOR/BRAKE
(OR CLUTCH/BRAKE)
56
(69)
30VDC
116
114
RELAY
112
2N 4401
5VDC
110
560 K
OPTICAL SHAFT POSITION SENSOR
OPTEC OPB 700
66'
47K
2N 4401
102
TIMER NATIONAL 555
1.0 MFD
0.01 MFD
99
4.7K
110
470K
2N 4401
LED
4.7K
11K
MICRO-CONTROLLER MICROCHIP PIC 12C508
98
OPTICAL MOTION DETECTOR AGILENT ADNS2051
4.7 MFD
0.1 CER
AVX KBR-18-00-MSA
64
95
XA
YA
2.2 MFD
0.1 CER
64'
74
36
97
"X' PULSES
'Y' PULSES
OPTICAL BOBBIN HOOK POSITION SENSOR
(CLUTCH/BRAKE EMBODIMENT ONLY)
65
65'
30
(30')

FIGURE 9

Figure 10

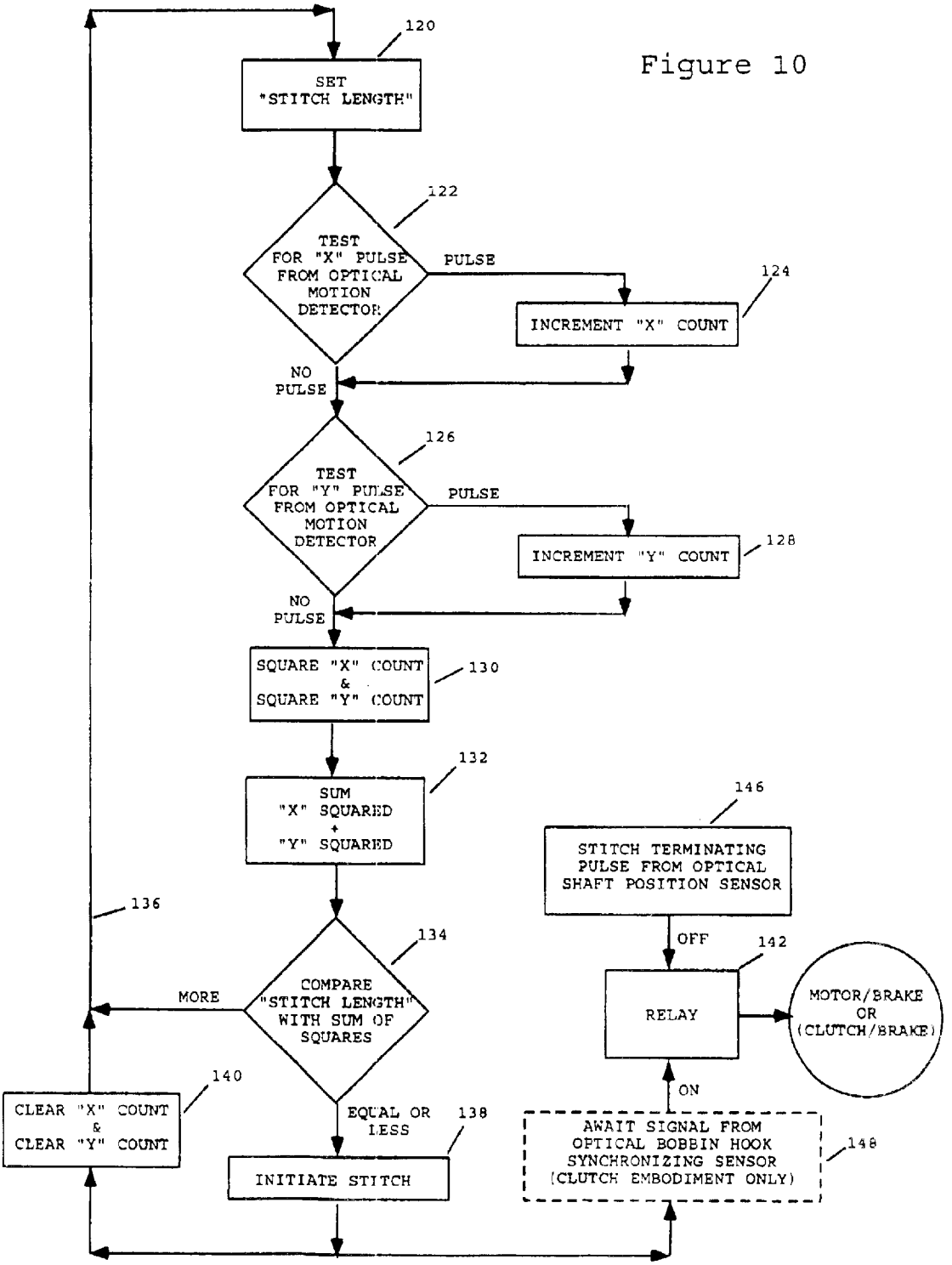

120
SET "STITCH LENGTH"
122
TEST FOR "X" PULSE FROM OPTICAL MOTION DETECTOR
PULSE
124
INCREMENT "X" COUNT
NO PULSE
126
TEST FOR "Y" PULSE FROM OPTICAL MOTION DETECTOR
PULSE
128
INCREMENT "Y" COUNT
NO PULSE
SQUARE "X" COUNT & SQUARE "Y" COUNT
130
SUM "X" SQUARED + "Y" SQUARED
132
136
134
COMPARE "STITCH LENGTH" WITH SUM OF SQUARES
MORE
EQUAL OR LESS
140
CLEAR "X" COUNT & CLEAR "Y" COUNT
138
INITIATE STITCH
146
STITCH TERMINATING PULSE FROM OPTICAL SHAFT POSITION SENSOR
OFF
142
RELAY
MOTOR/BRAKE OR (CLUTCH/BRAKE)
ON
AWAIT SIGNAL FROM OPTICAL BOBBIN HOOK SYNCHRONIZING SENSOR (CLUTCH EMBODIMENT ONLY)
148

FIGURE 11(A)

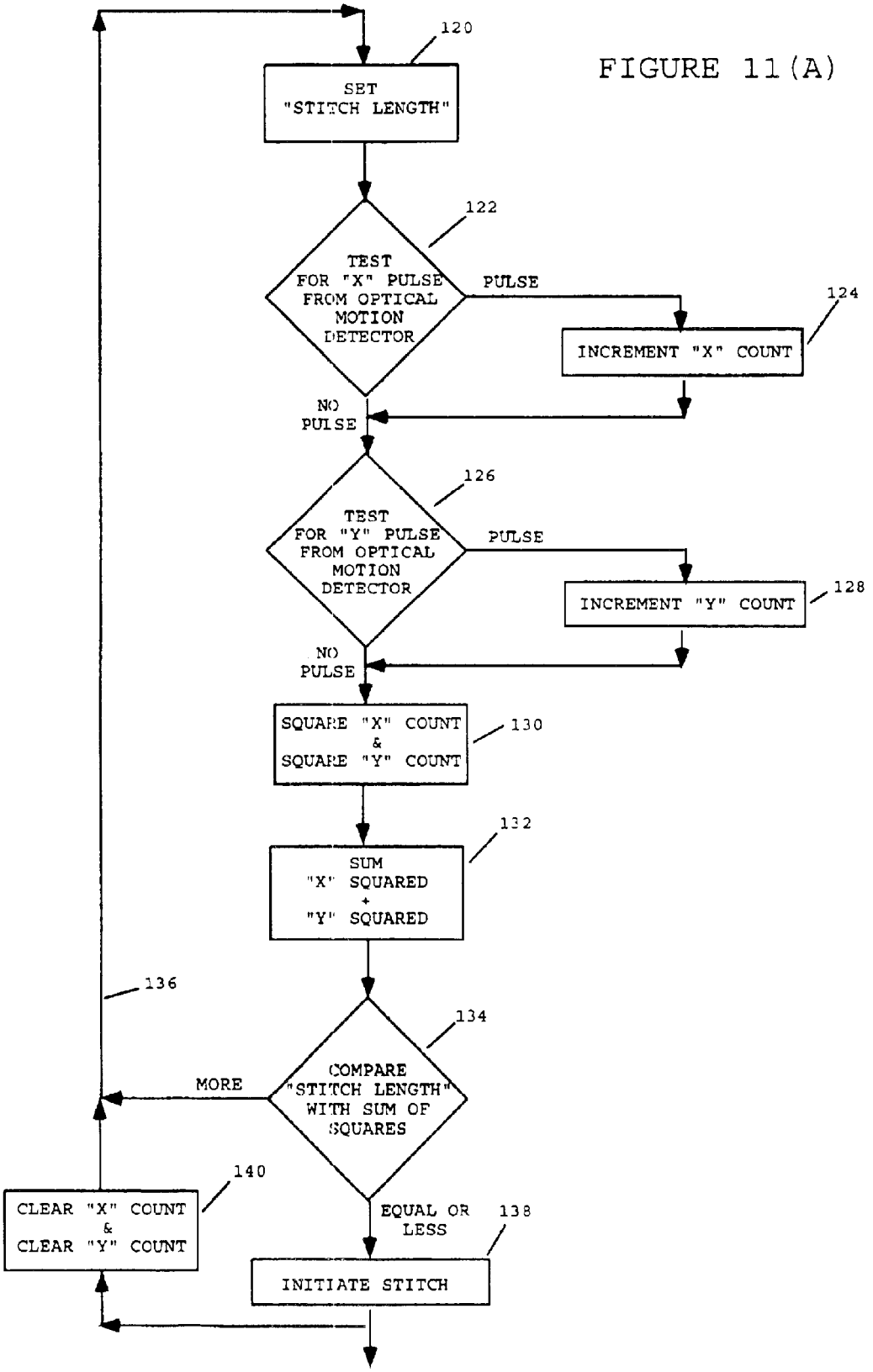
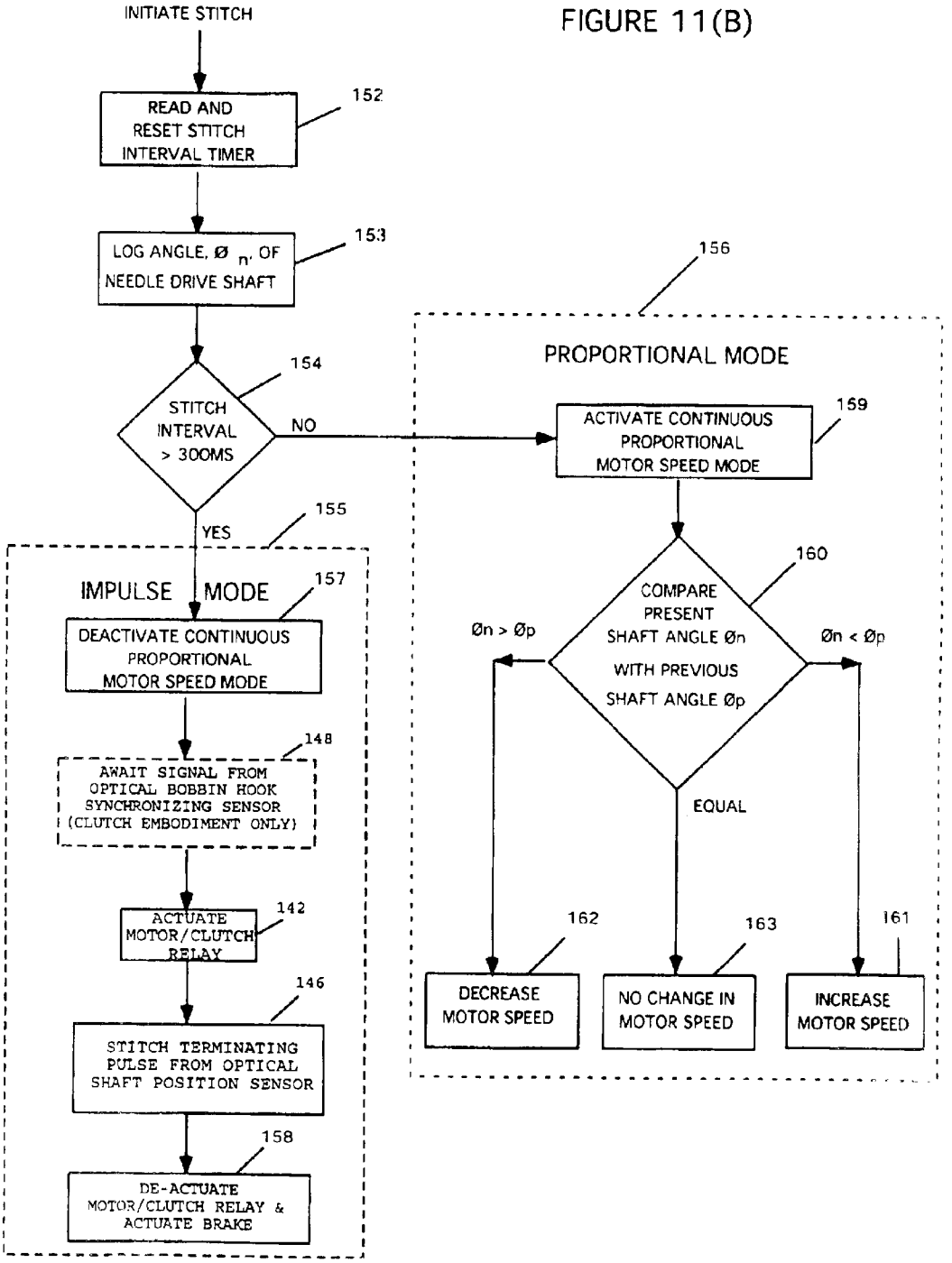

120
SET "STITCH LENGTH"
122
TEST FOR "X" PULSE FROM OPTICAL MOTION DETECTOR
PULSE
124
INCREMENT "X" COUNT
NO PULSE
126
TEST FOR "Y" PULSE FROM OPTICAL MOTION DETECTOR
PULSE
128
INCREMENT "Y" COUNT
NO PULSE
SQUARE "X" COUNT & SQUARE "Y" COUNT
130
SUM "X" SQUARED + "Y" SQUARED
132
136
134
COMPARE "STITCH LENGTH" WITH SUM OF SQUARES
MORE
140
CLEAR "X" COUNT & CLEAR "Y" COUNT
EQUAL OR LESS
138
INITIATE STITCH

FIGURE 11(B)


INITIATE STITCH
READ AND RESET STITCH INTERVAL TIMER
152
LOG ANGLE, Ø n, OF NEEDLE DRIVE SHAFT
153
156
PROPORTIONAL MODE
154
STITCH INTERVAL > 300MS
NO
ACTIVATE CONTINUOUS PROPORTIONAL MOTOR SPEED MODE
159
YES
155
160
IMPULSE MODE
157
COMPARE PRESENT SHAFT ANGLE Øn WITH PREVIOUS SHAFT ANGLE Øp
Øn > Øp
Øn < Øp
EQUAL
DEACTIVATE CONTINUOUS PROPORTIONAL MOTOR SPEED MODE
148
AWAIT SIGNAL FROM OPTICAL BOBBIN HOOK SYNCHRONIZING SENSOR (CLUTCH EMBODIMENT ONLY)
142
ACTUATE MOTOR/CLUTCH RELAY
162
163
161
DECREASE MOTOR SPEED
NO CHANGE IN MOTOR SPEED
INCREASE MOTOR SPEED
146
STITCH TERMINATING PULSE FROM OPTICAL SHAFT POSITION SENSOR
158
DE-ACTUATE MOTOR/CLUTCH RELAY & ACTUATE BRAKE

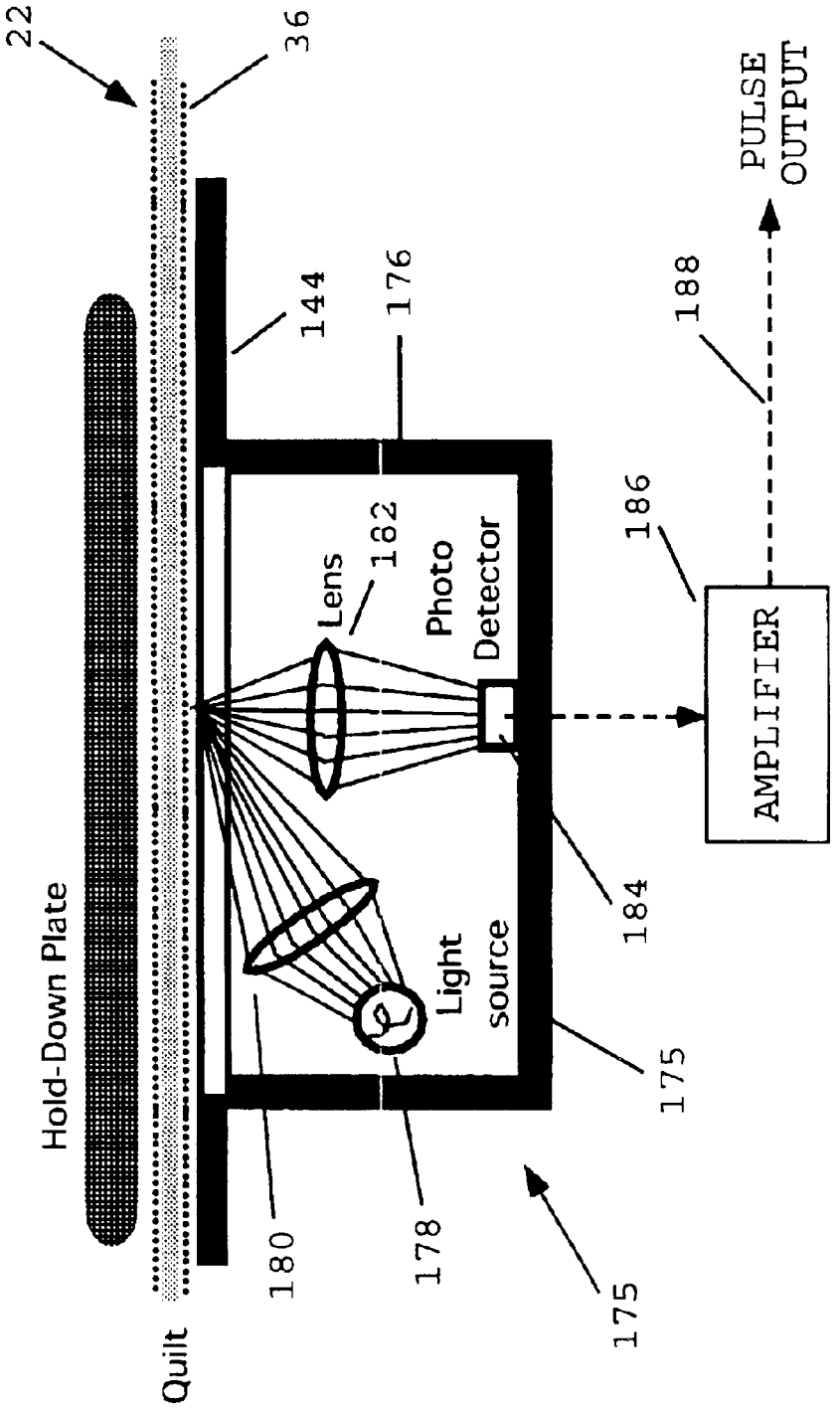

22
36
144
176
188
PULSE OUTPUT
186
182
Lens
Photo Detector
AMPLIFIER
Hold-Down Plate
184
Light source
175
180
178
175
Quilt

FIGURE 12

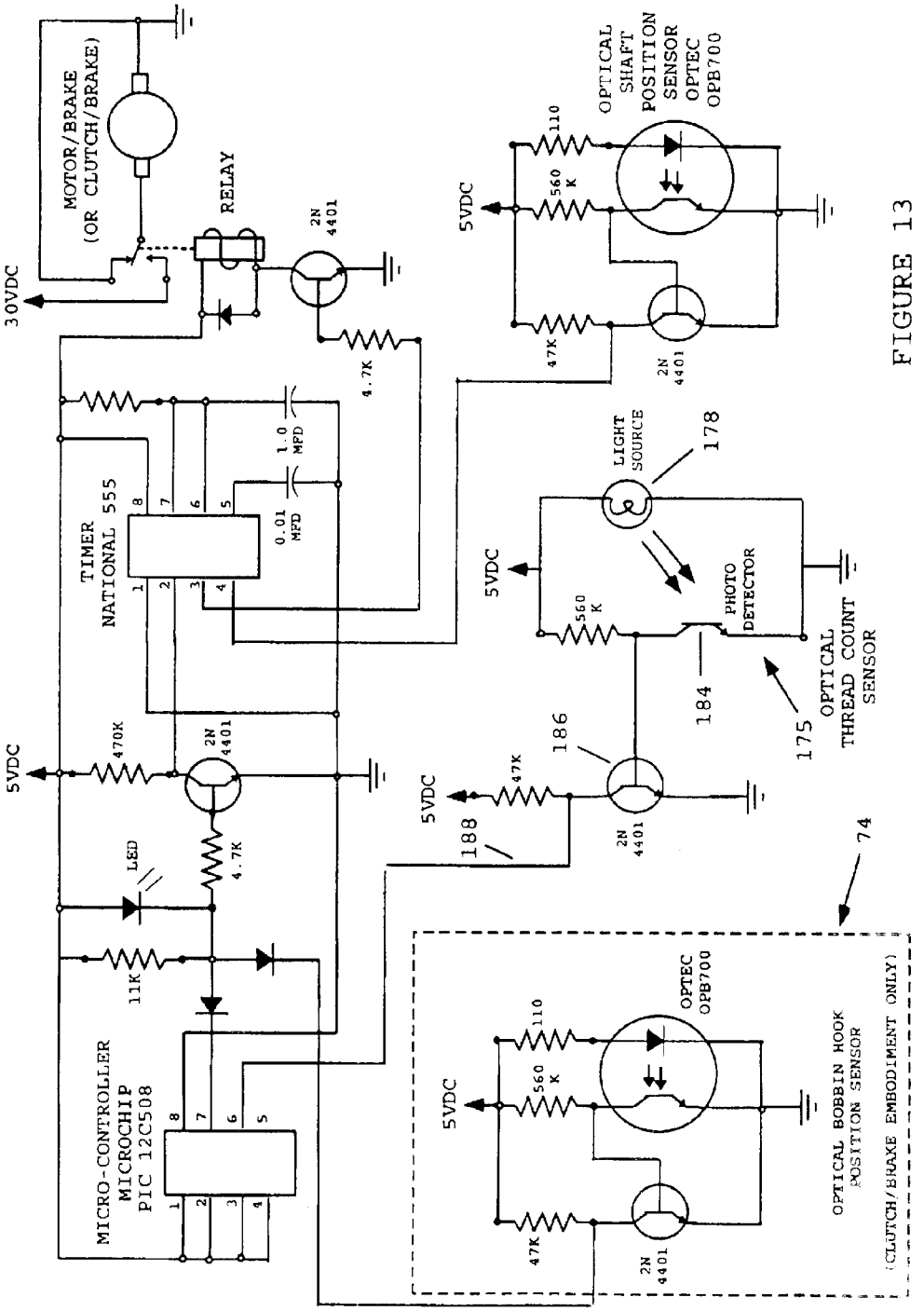
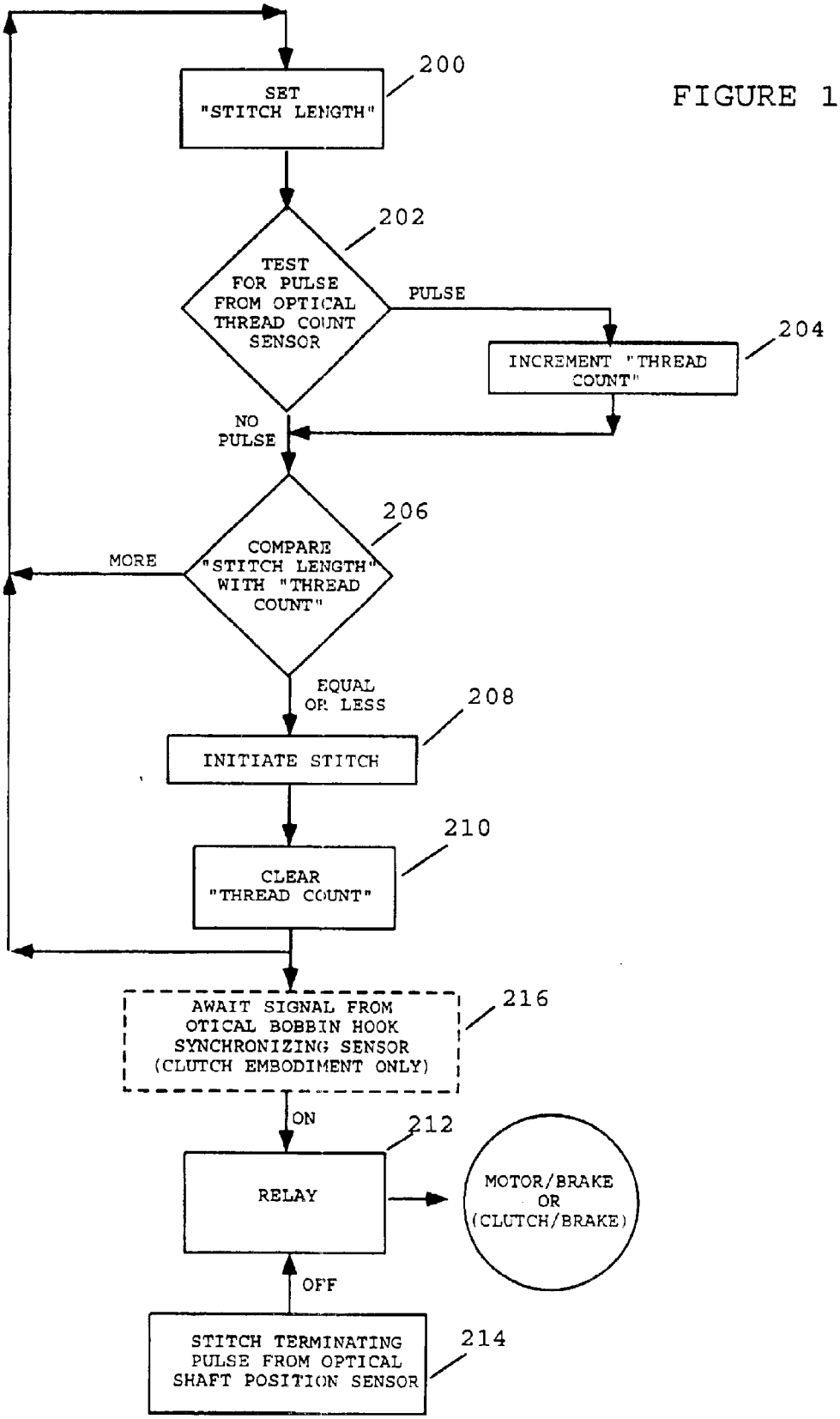

MOTOR/BRAKE
(OR CLUTCH/BRAKE)
RELAY
2N 4401
30VDC
4.7K
OPTICAL SHAFT POSITION SENSOR OPTEC OPB700
110
560 K
5VDC
47K
2N 4401
TIMER NATIONAL 555
1.0 MFD
0.01 MFD
LIGHT SOURCE
178
PHOTO DETECTOR
184
175
OPTICAL THREAD COUNT SENSOR
186
188
470K
LED
11K
MICRO-CONTROLLER MICROCHIP PIC 12C508
74
OPTEC OPB700
OPTICAL BOBBIN HOOK POSITION SENSOR
(CLUTCH/BRAKE EMBODIMENT ONLY)

FIGURE 13

FIGURE 14


SET "STITCH LENGTH"
200
TEST FOR PULSE FROM OPTICAL THREAD COUNT SENSOR
202
PULSE
INCREMENT "THREAD COUNT"
204
NO PULSE
COMPARE "STITCH LENGTH" WITH "THREAD COUNT"
206
MORE
EQUAL OR LESS
INITIATE STITCH
208
CLEAR "THREAD COUNT"
210
AWAIT SIGNAL FROM OTICAL BOBBIN HOOK SYNCHRONIZING SENSOR (CLUTCH EMBODIMENT ONLY)
216
ON
RELAY
212
MOTOR/BRAKE OR (CLUTCH/BRAKE)
OFF
STITCH TERMINATING PULSE FROM OPTICAL SHAFT POSITION SENSOR
214

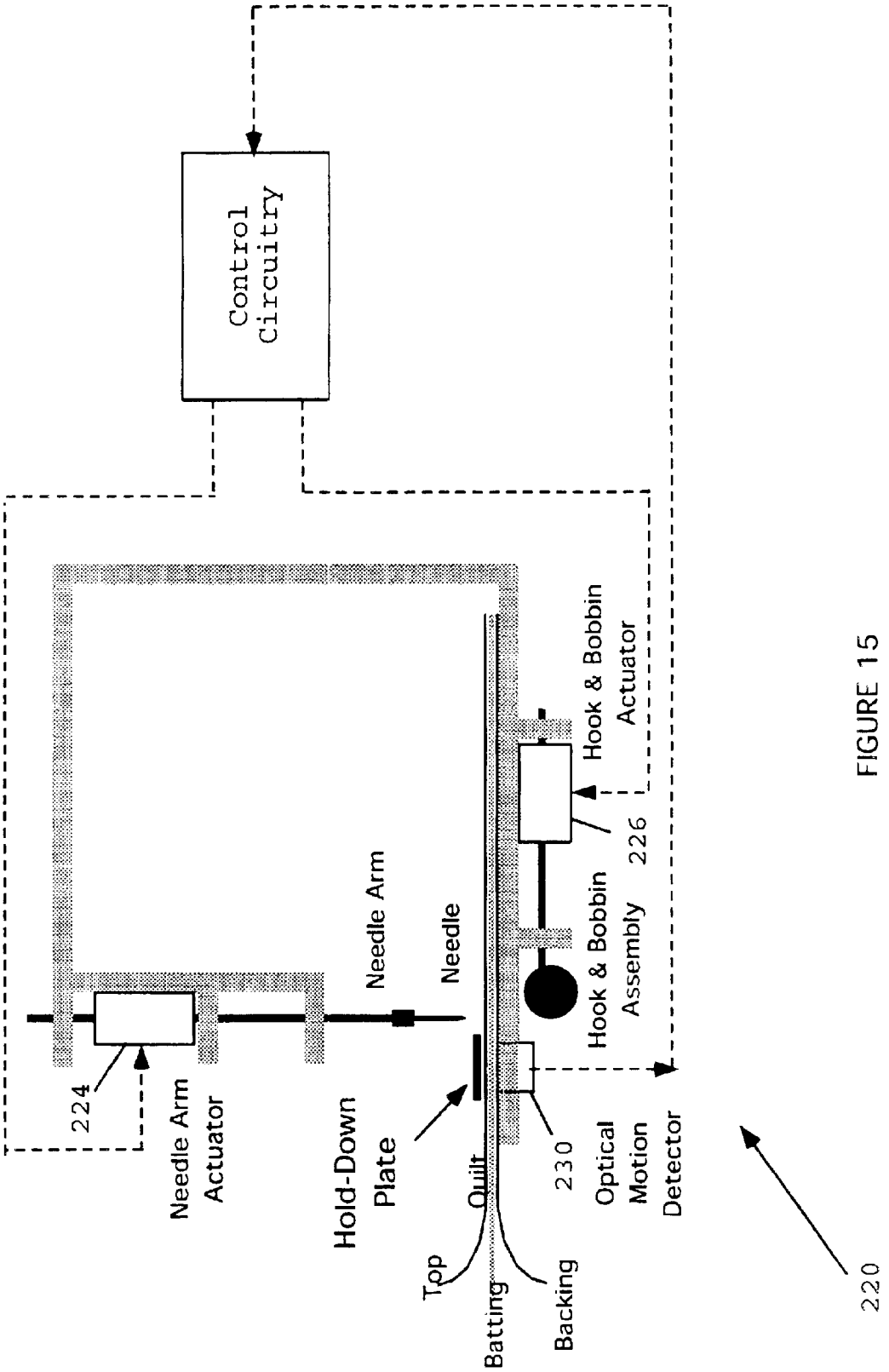

Control Circuitry
Hook & Bobbin Actuator
226
Hook & Bobbin Assembly
Needle Arm
Needle
224
Needle Arm Actuator
Hold-Down Plate
Quilt
230
Optical Motion Detector
Top
Batting
Backing
220

FIGURE 15

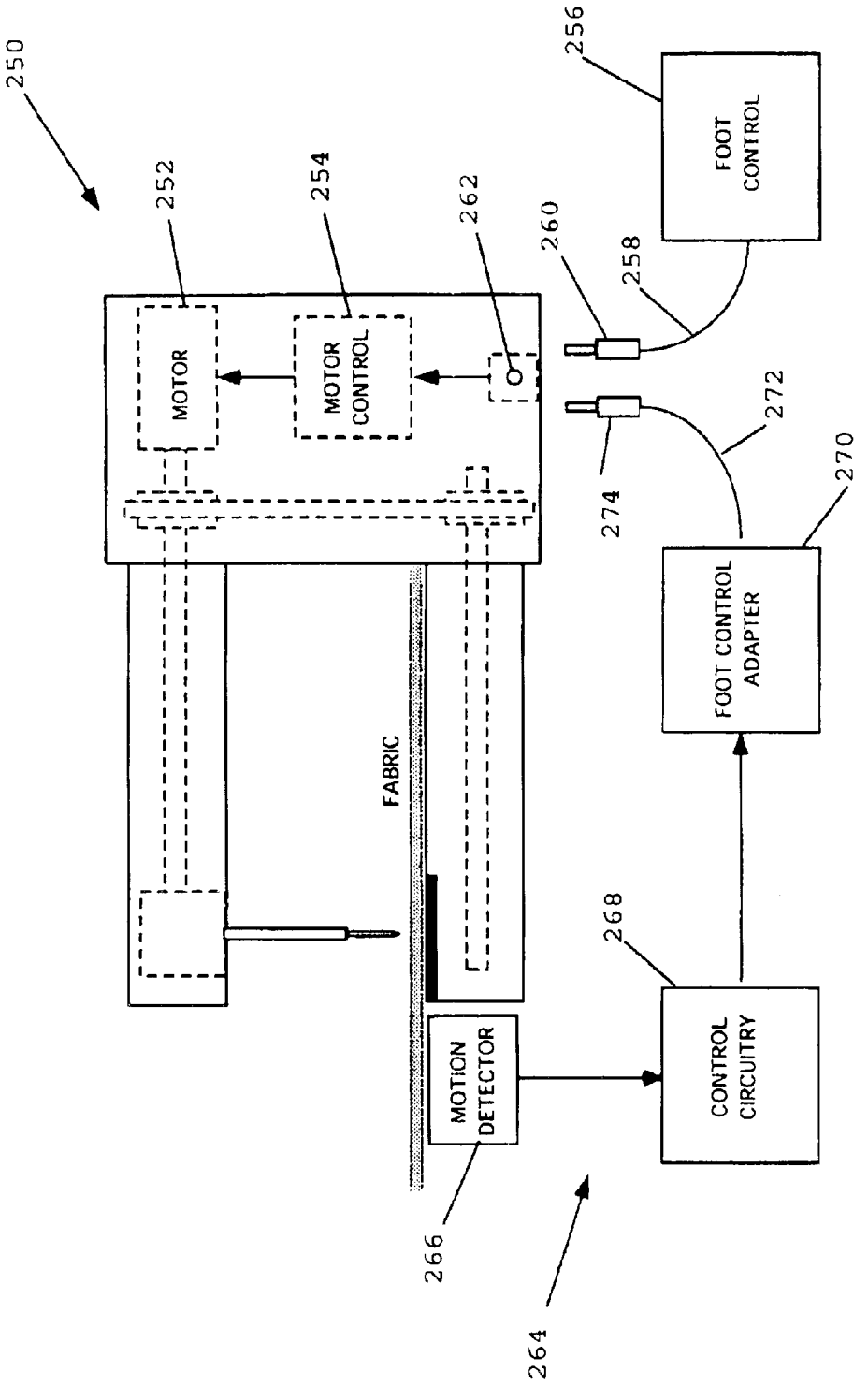

250
252
254
262
260
258
256
FOOT CONTROL
MOTOR
MOTOR CONTROL
272
274
270
FOOT CONTROL ADAPTER
FABRIC
268
MOTION DETECTOR
CONTROL CIRCUITRY
266
264

FIGURE 16

QUILTING METHOD AND APPARATUS

RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/447,159 filed 12 Feb. 2003.

FIELD OF THE INVENTION

This invention relates generally to a system for fastening together two or more flexible planar layers and more particularly to a method and apparatus for stitching together two or more fabric layers, as in quilting.

BACKGROUND OF THE INVENTION

Creating decorative quilts by hand has become a popular avocation. A typical quilt is comprised of at least two fabric layers which are stacked and stitched together. Generally the quilt is comprised of a "top" layer, a "bottom" or "backing" layer, and an intermediate "batting" layer. The top layer is typically decorative and is produced as a consequence of the creative and artistic effort of the quilt maker. The backing layer is usually simple and aesthetically compatible with the top. The batting layer generally provides bulk and insulation. The specific process of sewing the sandwich of the three planar layers together is generally referred to as "quilting". The quilting process usually consists of forming long continuous patterns of stitches which extend through and secure the top, backing, and batting layers together. Oftentimes stitch patterns are selected which have a decorative quality to enhance the overall aesthetics. A general goal of the quilting process is to produce precise consistent stitches that are closely and uniformly spaced.

Quilting traditionally has been performed by hand without the aid of a sewing machine. However, hand quilting is a labor-intensive process which can require many months of effort by a practiced person to create a single quilt. Accordingly, it appears that a trend is developing toward using machines to assist in the quilting process to allow most of the quilter's effort to be directed toward the creative and artistic aspects of the top layer.

Machine quilting can be performed in a variety of ways. For example, a user can operate a substantially conventional sewing machine in a "free motion" mode by removing or disabling the machine's feed dogs. This allows the user to manually move the stacked quilt layers relative to the machine's needle, either directly or via a quilt frame, to produce desired patterns of stitches. In practice, the sewing machine is run at a relatively constant speed as the user moves the stacked quilt materials under the needle. This process typically requires significant operator skill acquired after much practice to enable the operator to move the quilt stack in synchronism with the needle stroke to form high quality stitch patterns. Thus, free motion quilting with a conventional sewing machine requires significant user skill and yet frequently yields imperfect results, particularly when forming curved and intricate stitch patterns.

Machine quilting can also be performed by using a wide range of specialized hand guided quilting systems which have become available in recent years. The characteristics and features of such systems are discussed in an article which appeared in *Quilter's Newsletter Magazine* (QNM), April 2003, by Carol A. Thelen. The article identifies three categories of such systems; i.e., (1) Table top set-ups, (2) Shortarm systems, and (3) Longarm systems. They are generally characterized by a table which supports a frame and a quilting/sewing machine. The frame includes rollers which hold the quilt layers so as to enable a portion of the layered stack to be exposed for stitching while the remaining layer portions are stored on the rollers. The quilting/sewing machine rests on a carriage mounted for movement (e.g., along tracks) relative to the frame and table. The carriage is generally provided with handles enabling an operator to move the machine over the surface of the quilt. The QNM article further discusses optional add-ons and accessories enabling various electronic functions, including stitch regulation, to be added to basic shortarm or longarm systems.

SUMMARY OF THE INVENTION

The present invention is directed to a system for fastening together two or more flexible planar layers and more particularly to a quilting method and apparatus for enabling a user to readily produce uniform stitches for fastening together a stack of fabric layers.

Apparatus in accordance with the invention permits a user to freely manually move a stack of planar layers across a planar bed, or plate, beneath an actuatable stitch head. The apparatus includes a detector for detecting the movement of the stack proximate to the stitch head for controlling actuation of the stitch head. Consequently, an apparatus in accordance with the invention functions to automatically synchronize the delivery of stitch strokes to the movement of the stack. This enables the user to move the stack within a wide range of speeds, to start or stop the stack movement at will, and to guide the stack in any direction across the planar bed.

More particularly, a preferred apparatus in accordance with the invention includes a detector configured to detect stack movement within the throat space of a quilting/sewing machine by measuring the movement of at least one surface of the stack as it moves across the planar bed. Stack movement is preferably measured by determining translation of the stack along perpendicular X and Y directions.

Preferred embodiments of the invention employ a detector capable of measuring stack surface movement without physically contacting the stack. A preferred detector in accordance with the invention responds to energy e.g., light, reflected from a surface of the stack as it moves across the planar bed. The detector preferably includes a detection window located to collect reflected energy from a target area coincident with the stack surface (top and/or bottom) within the machine's throat space.

In a specific preferred embodiment, an optical detector is employed to provide output pulses representative of incremental translational movement of the stack along perpendicular X and Y directions. The output pulses are then counted to determine the distance the stack has moved. When the magnitude of movement exceeds a predetermined magnitude or threshold, a "stitch stroke" command is issued to cause the stitch head to insert a stitch through the stacked layers. As the user continues to freely move the stack across the planar bed, additional stitch stroke commands are successively issued to produce successive stitches synchronized with the user controlled stack motion.

In accordance with one aspect of the preferred embodiment, the stitch head is configured to rapidly execute a single stitch cycle in response to each stitch stroke command. More particularly, the head is preferably configured so that its needle is held in its full up position between stitch cycles to avoid obstructing the user's freedom of movement for the stack. During each stitch cycle, a needle drive mechanism causes the needle to rapidly drop to pierce the stack layers on the bed, insert a stitch, and then rapidly rise back to its full up position to await the next stitch stroke command.

Although a single stitch mode, or impulse mode, of operation is advantageous to enable a user to operate at slow stack speeds (preferably down to zero), at higher stack speeds, e.g., greater than 20 inches per minute, it is generally satisfactory to control the speed of a continuously running needle drive motor so as to be proportional to the speed of stack movement.

In accordance with another aspect of a preferred embodiment, a stack hold-down plate or "presser foot" is associated with the stitch head. During a stitch cycle, the presser foot holds the stack against the bed to assure proper stitch tension and facilitate the needle's upward movement out of the stack. Between stitch cycles, the force on the presser foot is relieved to allow the stack to be freely moved through the machine's throat space between the presser foot and the planar bed.

Although the preferred embodiments to be described herein comprise machines in which the elements of the invention are fully integrated, it is pointed out that alternative embodiments can adapt conventional sewing machines to operate in accordance with the present invention.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a block diagram of a quilting system in accordance with the invention for fastening stacked planar layers;

FIG. **2** is a diagrammatic illustration of a first embodiment of the invention utilizing a motor/brake assembly to control the stitch head;

FIGS. **3** and **4** are diagrammatic illustrations respectively showing the hold-down plate of FIG. **2** in its actuated and non-actuated positions;

FIGS. **5** and **6** respectively show side and end views of an exemplary quilting/sewing machine housing;

FIG. **7** is a diagrammatic illustration of a second embodiment of the invention, similar to FIG. **2**, but utilizing a clutch/brake assembly to control the stitch head;

FIG. **8** is a schematic illustration depicting a first optical motion detector embodiment for use in the systems of FIGS. **2** and **7**;

FIG. **9** is a schematic diagram of a control subsystem employing the detector of FIG. **8** for use in the embodiments of FIGS. **2** and **7**;

FIG. **10** is a flow chart depicting the operation of the controller of FIG. **9** in a single stitch, or impulse mode;

FIG. **11** (presented as **11**(A) and **11**(B)) comprises a flow chart similar to FIG. **10** but depicting dual mode operation, i.e., (1) impulse mode and (2) proportional mode;

FIG. **12** is a schematic illustration depicting a second alternative optical motion detector for use in the embodiments of FIGS. **2** and **7**;

FIG. **13** is a schematic diagram of a control subsystem employing the detector of FIG. **12** for use in the embodiments of FIGS. **2** and **7**;

FIG. **14** is a flow chart depicting the operation of the controller of FIG. **13**;

FIG. **15** is a diagrammatic illustration of a third alternative system embodiment; and

FIG. **16** is a block diagram depicting how a conventional sewing machine can be adapted to incorporate the present invention.

DETAILED DESCRIPTION

Attention is initially directed to FIG. **1** which depicts a generalized system **10** in accordance with the invention for

fastening together two or more flexible planar layers forming a stack **12**. The stack **12** is supported for guided free motion along a reference X-Y plane **14** proximate to a fastening, or stitch, head **15**. The head **15** is actuatable to insert a fastener, or stitch, through the stacked layers **12** to fasten the layers together. A motion detector **16** is provided to sense the movement of stack **12** across plane **14**. Control circuitry **18** responds to increments of stack movement to actuate the head **15** to insert uniformly spaced fasteners or stitches through the layers of stack **12**. As Will be described hereinafter, the detector **16** is preferably configured to measure the stack translational motion along perpendicular X, Y axes of reference plane **14** proximate to the stitch head **15**.

FIG. **2** illustrates a first preferred embodiment **20** of the system of FIG. **1** for stitching together fabric layers of a stack **22**. The embodiment **20** is generally comprised of a mechanical machine portion **26**, including an actuatable stitch head **28**, and an electronic control subsystem **30** for actuating the head **28** in response to movement of the stack **22**. Although the planar layers of stack **22** can consist of a wide variety of materials intended for different applications, the preferred embodiments to be discussed hereinafter are particularly configured for stitching together fabric layers, e.g., a top layer **32**, an intermediate batting layer **34**, and a bottom backing layer **36**, to form a quilt.

The machine portion **26** of FIG. **2** is generally comprised of a frame **40** configured to support the stitch head **28** above a bed **44** providing a substantially horizontally oriented planar surface **45**. The stitch head **28** includes a needle bar **46** supporting a needle **48** for reciprocal vertical movement essentially perpendicular the planar surface **45**. The bed surface **45** is configured for supporting the layered stack **22** so as to enable a user to freely manually guide the stack **22** across the surface **45**. A hold-down plate, or presser foot, **50** is provided to selectively press the stack **22** against the bed surface, as will be explained hereinafter, to assure proper stitch tension and to assist the needle to pull upwardly out of the stack after inserting a stitch.

A conventional hook and bobbin assembly **52** is mounted beneath the bed **44** in alignment with the needle **48**. The stitch head **28** including needle bar **46** and needle **48**, operates in a substantially conventional manner in conjunction with the hook and bobbin assembly **52** to insert a stitch through the stack **22** at a fixedly located opening, or stitch site, **54** on the bed. During a stitch cycle when the needle **48** is lowered to its down position to pierce the stack layers (FIG. **3**), the hold-down plate **50** is also lowered to press the stack layers against the bed **44** to achieve proper stitch tension and assist the needle to pull up out of the stack. After completion of a stitch cycle, the needle **48** and hold-down plate **50** are raised (FIG. **4**). As will be discussed hereinafter, the raised position of the hold-down plate (FIG. **4**) is preferably selected to loosely bear against the stack to maintain the backing layer **36** (FIG. **2**) against the bed **44** to assure detection by detector **16** while also permitting the stack to be freely moved across the bed **44**.

The preferred machine portion **26** of FIG. **2** is further depicted as including a motor/brake assembly **56** which functions to selectively provide operating power and braking via a suitable transmission system **58** to an upper drive shaft **60** and a lower drive shaft **62**. The upper drive shaft **60** transfers power from the motor/brake assembly **56** to stitch head **28** for moving the needle **48**. The lower drive shaft **62** transfers power from the motor/brake assembly **56** to the hook and bobbin assembly **52**.

The stitch head **28** and hook and bobbin assembly **52** operate cooperatively in a conventional manner to insert

stitches through the layers of stack **22** at stitch site **54**. That is, when the stitch head cycle is initiated, needle **48** is driven downwardly to pierce the stacked layers **32**, **34**, **36** and carry an upper thread (not shown) through the stitch site opening **54** in bed **44**. Beneath the bed **44**, the hook (not shown) of assembly **52** grabs a loop of the upper thread before the needle **48** pulls it back up through the stack which is held down by presser foot **50**. The upper thread loop grabbed by the hook is then locked by, a thread pulled off the bobbin (not shown) of assembly **52**.

The system of FIG. **2** includes a transducer, or detector, **64** for detecting the movement, or more specifically, the translation of the stack **22** on bed **44** for controlling the motor/brake assembly **56** via control circuitry **65**. As will be discussed in greater detail hereinafter, in operation, a user is able to freely move the layered stack **22** on bed **44** relative to the fixedly located stitch head **28** while the detector **64** produces electronic signals representative of the stack movement. Control circuitry **65** then responds to the detected stack movement for controlling the issuance of a stitch from head **28**. The control subsystem **30**, in addition to including motion detector **64** and control circuitry **65**, also preferably includes a shaft position sensor **66**. The shaft position sensor **66** functions to sense the particular rotational position of the upper drive shaft **60** corresponding to the needle **48** being in its full up position. As will be seen hereinafter, the control circuitry **65** responds to the output of sensor **66** to park the needle **48** in its full up position between successive stitch cycles. This action prevents the needle from interfering with the free translational movement of the stack **22** on bed **44**.

In accordance with the invention, an operator guides a fabric stack across the horizontally oriented bed **44** beneath the vertically oriented needle **48**. The motion detector **64** in accordance with the invention is mounted to monitor a target area coincident with a surface layer (top and/or bottom) of the stack **22** as the stack is moved across the bed **44**. As will be discussed hereinafter, the detector can be considered as having a window focused on the stack surface proximate to the needle penetration site. The detector can be variously physically mounted; e.g., above the stack looking down at the stack top surface or below the stack looking up at the stack bottom surface.

Although the motion detector **64** of FIG. **2** can take many different forms, including both noncontacting devices (e.g., optical detector) and contacting devices (e.g., track ball), it is much preferred that it detect stack movement without physically contacting the fabric layers. Accordingly, a preferred motion detector in accordance with the invention comprises a device for responding to energy reflected from, or sourced by, the stack. Although this energy can be of several different forms (e.g., ultrasonic, RF, magnetic, electrostatic, etc.), the preferred detector embodiment employs an optical motion detector (represented in FIG. **8**) utilizing, for example, an optical chip ADNS2051 marketed by Agilent Technologies. Alternative detectors for measuring stack can employ technologies such as accelerometers, resistive devices, etc.

Suffice it to say at this point that the accurate measurement of stack movement depends, in part, upon the stack target layer, e.g., backing layer **36**, being positioned near the focus of the motion detector window. The aforementioned hold-down plate or presser foot **50** assists in maintaining the stack layers at a certain distance from the detector window. In a preferred embodiment, the hold-down plate **50** has a flat smooth bottom surface **51** for engaging the stack **22** and is fabricated of transparent material to avoid obstructing a user's view of the stack layers proximate to the needle **48**.

FIGS. **3** and **4** respectively illustrate the actuated and non actuated positions of the hold-down plate **50**. In FIG. **3**, shaft **80** is moved down during the stitch cycle to cause the plate **50** to apply spring pressure, attributable to spring **82**, to the stack **22**. Between cycles (FIG. **4**), shaft **80** is moved up so the pressure of plate **50** against stack **22** is relieved to reduce motion-inhibiting friction of the plate against the stack. Nevertheless, during a non-stitch interval between cycles, the plate **50** is positioned closely enough to loosely hold the stack against the bed **44**.

Note in FIGS. **3** and **4** that the hold-down plate **50** is attached to shaft **80** that slides, loaded by spring **82**, up and down, relative to a presser foot arm **83**. Also note that FIG. **4** shows the needle arm **46** assisting to pull the spring-loaded shaft **80** upwardly. The travel range of the hold-down plate **50** permits free horizontal motion of the quilt stack across the bed between stitch cycles but constrains vertical motion of the stack sufficiently to assure that the backing layer surface **36** is held against the bed surface and near the focus of the window of motion detector **64**.

FIGS. **5** and **6** schematically depict a typical quilting/sewing machine housing **84** for accommodating the physical components of the system of FIG. **2**. The housing **84** comprises an upper arm **85** which contains the upper drive shaft **60** and a lower arm **86** containing the lower drive shaft **62**. The housing upper and lower arms **85** and **86** extend from a vertically oriented machine arm **87**. The upper and lower arms **85**, **86** are vertically spaced from one another and together with the machine arm **87** define a space which is generally referred to as the throat space **88**. The needle **48** descends vertically from the upper arm into the throat space **88** for reciprocal movement toward and away from the lower arm **85**. The lower arm **85** carries the bed **44** which is sometimes referred to as the throat plate. The distance between the needle and the machine arm is generally referred to as the throat length.

FIG. **8** depicts a preferred motion detector **64** comprising a housing **90** having a light collecting window **91**. A light source, e.g., a light-emitting diode (LED) **92**, is mounted in housing **90** and illuminates (via mirrors **93** and window **91**) a target area coincident with the surface of backing layer **36** just above window **91**. The light reflected from layer **36** is collected by a lens system **94** and is applied to the optical chip **95** (e.g., Agilent ADNS 2051). The chip **95** internally includes both a tiny CMOS array camera (not shown) which successively acquires images from the target area at about 1500 pictures per second and an associated digital signal processor or DSP (not shown). The signal processor operates at several million instructions per second to detect patterns in the acquired images and to determine, based on changes in a sequence of successive images, how those patterns have moved. As a consequence, the chip **95** is able to provide output pulses on lead **96** representative of incremental translation of the backing layer **36** portion coincident with the target area in an X direction and output pulses on lead **97** representative of incremental translation of the backing layer **36** in a Y direction.

FIG. **7** illustrates a second alternative system embodiment **68** which contains a mechanical machine portion **26'** and an electronic control subsystem **30'**, similar to the corresponding portions **26** and **30** of the embodiment of FIG. **2**. However, the embodiment of FIG. **7** differs from FIG. **2** primarily in that it uses a clutch/brake assembly **69** to control power transfer from motor **70** to the stitch head **28'**, in lieu of the aforementioned motor/brake assembly **56** of FIG. **2**. Additionally, the hook and bobbin assembly **52'** in FIG. **7** is driven continuously by motor **70** with the position of the

bobbin hook (not shown) therein being sensed by a hook position sensor **71**. The outputs of stack motion detector **64'**, shaft position sensor **66'**, and hook position sensor **71** are all applied as inputs to control circuitry **65'** whose output controls the clutch/brake assembly **69** to selectively actuate the stitch head **28'**.

Attention is now directed to FIG. **9** which depicts a circuit diagram relevant to both the control subsystem **30** of FIGS. **2** and **30'** of FIG. **7**. Note that FIG. **9** shows the optical motion detector **64** (**64'**) and the shaft position sensor **66** (**66'**) which are relevant to both FIGS. **2** and **7**. Detector **64** (**64'**) and sensor **66** (**66'**) are connected to provide data signals to control circuitry **65** (**65'**) which is comprised primarily of a controller **98** (e.g., microcontroller chip Microchip PIC 12C508) and a timer circuit **99** (e.g., National 555). FIG. **9** also depicts in dashed line the hook position sensor **74** of FIG. **7** which provides a signal to timer **99** when the hook (not shown) reaches an active position. The shaft position sensor **66** (**66'**) and hook position sensor **74** preferably comprise devices which respond to optical stimuli respectively carried by shaft **60** and the hook of assembly **72**, to produce signals for application to the control circuitry. Such optical stimuli would most typically comprise differentially reflective markers respectively placed on the upper drive shaft **60** and the hook of assembly **72**. In operation, the microcontroller **98** functions to count output pulses provided by motion detector chip **95** on leads **96** and **97** which respectively represent increments of movement of the quilt backing layer **36** along orthogonal X and Y axes. When the microcontroller **98** recognizes a sufficient cumulative movement, it issues a signal to timer circuit **99**. Alternatively, in the particular case of the clutch/brake embodiment of FIG. **7**, the microcontroller signal is gated by the output of hook position sensor **74** so that it is applied to the timer circuit **99** only when the bobbin hook is in the desired position. The timer circuit **99** applies the stitch command signal on output **110** to load transistor **112**. Transistor **112** controls relay **114** which is shown as operating a single pole double, throw switch **116**. In the actuated, lower, position as depicted in FIG. **9**, switch **116** applies power to drive the motor of motor/brake assembly **56** of FIG. **2** or alternatively, engages the clutch of clutch/brake assembly **69** of FIG. **7**. The relay **114** is deactuated via the timer **98** and the transistor **112** by a pulse on line **102** from the shaft position sensor **66**. In the deactuated, upper, position as depicted in FIG. **9**, switch **116** closes a shunt path to thus brake the drive train.

Attention is now directed to FIG. **10** which comprises a flow diagram depicting the algorithmic operation of microcontroller **98** for controlling the motor/brake assembly **56** of FIG. **2** or the clutch/brake assembly **69** of FIG. **7** to produce a single stitch. In FIG. **10**, first note block **120** which functions to initialize a stitch cycle by acquiring a "stitch length" value which typically was previously entered via a user input. With the stitch length value set in block **120**, the algorithm proceeds to decision block **122** which tests for stack translation in the X direction, i.e., for an X pulse on lead **96** from the optical chip **95**. If a pulse is detected, then a store X count is incremented, as represented by block **124**. After execution of blocks **122**, **124**, operation proceeds to decision block **126** which tests for Y translation, i.e., for a Y pulse on lead **97** of the optical motion chip **95**. If a Y pulse is detected, then a stored Y count is incremented as represented by block **128**. Operation then proceeds from blocks **126** or **128** to block **130**. Blocks **130** and **132** essentially represent steps for determining the resultant stack movement magnitude attributable to the measured X and Y components of motion utilizing the Pythagorean theorem. That is, in block **130**, the X count value is squared and the Y count value is squared. Block **132** sums the squared values calculated in block **130** to produce a value representative of the resultant stack movement.

Block **134** compares the square of the preset switch length value with the magnitude derived from block **132**. If the magnitude of the resultant movement is less than the preset stitch length, then operation cycles back via loop **136** to the initial block **120**. If on the other hand, the resultant magnitude exceeds the preset stitch length, then operation proceeds to block **138** to initiate a stitch. In block **140**, the X and Y counts are cleared before returning to the initial block **120**. Additionally, after block **138**, the relay (**114** in FIG. **9**) is energized by execution of block **142** to actuate the motor/brake assembly **56** (FIG. **2**) or the clutch/brake assembly **69** (FIG. **7**). Note, however, that termination of block **142** requires a terminating pulse from the shaft position sensor (represented by block **146**) indicating that the upper drive shaft has reached the position to park the needle in its full up position. FIG. **10** also depicts a dashed block **148** between blocks **138** and **142**. Block **148** is relevant to the embodiment of FIG. **7** and indicates that the execution of block **142** is deferred until receipt of an enabling signal from the hook position sensor **74** of FIG. **9**.

Whereas FIG. **10** depicts the algorithm for operation in the impulse, or single stitch, mode, FIG. **11** (presented as **11**(A) and **11**(B)) depicts dual mode operation, i.e., impulse mode at slow stack speeds and a continuous proportional mode at higher stack speeds. It is preferable to provide such a dual mode capability to be able to operate more smoothly at higher stack speeds. By way of explanation, it will be recalled that in order to accommodate slow stack speed operation, e.g., less than 20 inches per minute, it is desirable that each stitch command initiate a very rapid needle stroke to avoid the needle interfering with stack movement. As the stack translation speed and needle stroke rate increase, the needle's interference with stack movement diminishes. Thus, at fast stack speeds, e.g., greater than 20 inches per minute (or 200 stitches per minute assuring an exemplary 0.1 inch stitch length), it is appropriate to switch to a proportional mode in which the needle is continuously driven at a rate substantially proportional to stack speed. At a speed of 200 stitches per minute, each needle cycle consumes less than about 300 milliseconds. Accordingly, the algorithm depicted in FIG. **11**(B) includes a step which tests for the time duration between successive stitch commands, i.e., a stitch time interval. If the duration of this interval is less than an exemplary 300 milliseconds, then operation proceeds in the proportional mode. An alternative embodiment of the invention (not shown) could operate solely in the proportional mode.

Note that FIG. **11**(A) is identical to FIG. **10** through the stitch command or "Initiate Stitch" block **138**. FIG. **11**(B) shows that block **138** is followed by block **152** which reads and resets a stitch interval timer (which can be readily implemented by a suitable microcontroller) which times the duration between successive stitch commands and records the angular position θ_n of the needle drive shaft **60** (block **153**). Decision block **154** then tests the interval timer duration previously read in block **152** to determine whether it is greater than the aforementioned exemplary 300 millisecond interval. If yes, operation proceeds to the impulse mode **155**. If no, operation proceeds to the proportional mode **156**.

Operation in the impulse mode **155** is essentially identical to the operation previously described with reference to FIG.

10 with regard to blocks **142**, **146**, **148**. However, FIG. **11**(B) additionally shows a block **157** in the impulse mode which can be executed to assure deactivation of the proportional mode and block **158** which deactuates a motor/clutch relay and actuates a brake after a stitch is delivered to park the needle in its up position.

Operation in the proportional mode **156** includes step **159** which activates motor speed control operation. A motor speed control capability is a common feature of most modern sewing machines with motor speed being controlled by the user, e.g., via a foot pedal, and/or by built-in electronic control circuitry.

After block **159**, decision block **160** is executed. To understand the function of decision block **160**, it must first be recognized that as stack speed is increased, thus generating shorter duration stitch intervals, the shaft angle position θ_n read in block **153** will decrease, in the absence of an adjustment of motor/needle shaft speed. In other words, a newly read shaft angle θ_n will be smaller than a previously read shaft angle θ_p. Block **160** functions to compare θ_n and θ_p if stack speed increases. If θ_n is smaller, the motor speed must be increased (block **161**) to deliver stitches at an increased rate to maintain stitch length uniformity.

On the other hand, if stack speed is reduced so that en is greater than θ_p, motor speed is decreased (block **162**) in order to produce uniform length stitches. If stack speed remains constant, then θ_n equals θ_p and no motor sped adjustment is called for (block **163**).

From the foregoing, the operation of the systems of FIGS. **2** and **7** in accordance with the invention should be readily appreciated. By way of summary, it should be understood the system enables a user to freely translate the layered stack **22** over the bed **44**. The detector **64** senses the movement of the stack to produce X and Y pulses representative of incremental translational movement with respect to orthogonal X and Y axes. The microcontroller **98** (FIG. **9**) functions to count the X and Y pulses and determine when the resultant movement is at least equal to the preset stitch length. When this occurs, relay **114** is actuated to supply power via switch **116** to the motor/brake assembly **56** of FIG. **2** (or the clutch/brake assembly of FIG. **7**) to initiate a single stitch stroke. That is, actuation of relay **114** throws switch **116** to its lower position (FIG. **9**), thus causing the motor to spin up rapidly to transfer power to stitch head **28** and the hook and bobbin assembly **52**. The upper and lower shafts **60**, **62** rotate until the upper shaft marker passes under the shaft position sensor **66**. When the shaft marker is detected, switch **116** is thrown to its upper position thus removing power to the motor/brake assembly **56** and shunting the assembly to quickly arrest the motion of, i.e., brake, the rapidly turning shafts. In order to assure free movement of the quilt stack, the shaft marker is placed so as to stop the needle in its full up position. To further assure free movement, the stitch stroke is caused to occur very rapidly so that the percentage of time the quilt layers are "trapped" by the needle and hold down plate **50** is very short. This can be accomplished by assuring that the motor/brake assembly uses an abundantly powered motor and a very rapid braking action, e.g., a DC motor employing an electric shunt for dynamic braking.

Attention is now directed to FIG. **12** which illustrates an optical motion detector embodiment **175** which is alternative to the embodiment **64** shown in FIG. **8**. It will be recalled that the embodiment of FIG. **8** operates by capturing a sequence of images and then comparing those images to detect motion of the quilt backing layer **36**. The embodiment **175** of FIG. **12** operates instead to count threads (warp and/or woof) as they cross the focal point of a light beam.

With continuing reference to FIG. **12**, note that the detector embodiment **175** is comprised of a housing **176** preferably mounted beneath the bed **144**. The housing contains a light source **178** which transmits light through lens system **180** to produce a beam focused against the backing layer **36** of the quilt material stack **22**. The reflected light from the backing layer is collected by lens system **182** and coupled to a photodetector **184**. The photodetector **184** generates a detectable signal change for each thread crossing the focal point of the beam incident on the backing layer **36**. The output of photodetector **184** drives an amplifier **186** to produce a pulse output **188** representing thread crossings, i.e., backing layer motion.

Attention is now directed to FIG. **13** which illustrates a circuit diagram of a control subsystem substantially identical to that shown in FIG. **9** except that it incorporates the optical motion detector **175** of FIG. **12** in lieu of the optical motion detector **64** of FIG. **8**. More particularly, note that FIG. **13** shows light source **178** illuminating photodetector **184** which drives amplifier **186** to produce output pulses on lead **188**. Lead **188** is connected to the input of the aforediscussed microcontroller **96**.

Attention is now directed to FIG. **14** which illustrates a flow diagram depicting the algorithmic operation of the microcontroller **96** of FIG. **13** when used in conjunction with the optical motion detector **175**. A stitch cycle in accordance with FIG. **14** starts with block **200** which functions to acquire a "stitch length" value. Operation proceeds from block **200** to decision block **202** which looks for a pulse on lead **188** (FIG. **13**) from the optical detector **175**. If no pulse is detected, operation proceeds directly to decision block **206**. If a pulse is detected, operation proceeds to block **204** which increments a stored thread count, prior to proceeding to decision block **206**. Block **206** compares the preset stitch length value with the current thread count. If the preset stitch length is greater than the current thread count, then operation loops back to the initial block **200**. On the other hand, if the stitch length is equal to or less than the current thread count, then operation proceeds to block **208** to initiate a stitch. In block **210**, the current thread count is cleared or reset to zero and operation loops back to the initial block **200**. Additionally, after execution of block **210**, the output relay **114** is energized in block **212** to actuate the motor/brake assembly **56** or clutch/brake assembly **69**. However, as will recalled from the flow diagram of FIG. **10**, the termination of block **212** requires a terminating signal from the shaft position sensor **66** (represented by block **214**) to indicate that the needle is in its full up position. FIG. **14** also depicts dashed block **216** between blocks **210** and **212**. Block **216** is relevant to the embodiment of FIG. **7** and indicates that the execution of block **212** is deferred until receipt of an enabling signal from the hook position sensor **74** shown in FIG. **13**.

It is pointed out that FIG. **14** only demonstrates operation in a single stitch, or impulse, mode but it should be understood that alternative embodiments can function solely in a continuous proportional mode or in a dual mode system by incorporating the steps depicted in FIG. **11**(B).

Embodiments of the invention can be configured to produce a wide range of uniform stitch lengths. For typical quilting applications, a stitch length of about 2.5 mm (1/10 in.) is considered attractive by a significant segment of the quilting community. In typical use by an exemplary user, it is expected that the stack would be moved on the order of

one inch per second which would equate to ten stitches per inch or ten stitches per second (i.e., 100 milliseconds per stitch). In this exemplary situation, if the stitch cycle duration is limited to 50 milliseconds or less, the needle **48** and hold-down plate **50** would capture the stack less than 50% of the time thus providing the user with a sensation of free stack movement.

Although only a limited number of specific embodiments have been described herein, it should be recognized that many further alternative arrangements will occur to those skilled in the art which fall within the spirit of the invention and the intended scope of the appended claims.

For example only, FIG. **15** illustrates a third exemplary embodiment **220** alternative to the embodiments of FIGS. **2** and **7**. The embodiment **220** differs primarily in that instead of using a common drive train, embodiment **220** uses separate electric actuators **224**, **226** for respectively driving the stitch head and hook and bobbin assembly. The actuators **224** and **226** are controlled by control circuitry **228** in response to signals supplied by motion detector **230** representative of stack movement.

Although the preferred embodiments described herein comprise machines in which the elements of the invention are fully integrated, it is recognized that an alternative embodiment can be provided for after market adapting of a conventional sewing machine to operate in accordance with the invention. More particularly, attention is directed to FIG. **16** which depicts a conventional sewing machine **250** having a drive motor **252**. The drive motor is typically controlled by motor control circuitry **254** which can control motor speed and other aspects or motor operation. Motor speed is typically controlled by a user input provided by a foot control **256** via a cable **258** and plug **260** which mates with a connector **262**.

A stitch control module **264** in accordance with the present invention is intended to be plugged into connector **262** in place of original foot control **256** to operate the needle at a rate proportional to movement of a fabric stack. The module **264** is comprised of a motion detector **266**, as previously discussed, mounted to measure stack movement within the throat space of machine **250**. The detector **266** is connected to control circuitry **268** which drives a foot control adapter **270**. The adapter **270** is configured to accept speed control input commands from control circuitry **268** and, in turn, output commands, i.e., control signals which simulate those provided by the original foot control **256**. The adapter output control signals are coupled via cable **272** to plug **274** for mating with connector **262**. Inasmuch as different machines may have different interfaces for coupling the original foot control **256** to the connector **262** and motor control circuit **254**, the foot control adapter **270** and plug **274** should be configured to be compatible with the particular sewing machine being adapted.

From the foregoing, it should be understood that the described quilting/sewing apparatus enables a user to manually grasp a fabric layer stack to move it across a planar bed to produce uniform length stitches through the stack. It should be understood that the user could alternatively choose to mount the stack on a simple commercially available frame enabling the user to grasp the frame in order to move the stack across the bed. It is also pointed out that the quilting/sewing machine described herein can be used in a hand guided quilting system having a frame for holding the fabric stack and a moveable carriage for supporting the quilting/sewing machine.

What is claimed is:

1. An apparatus for stitching together two or more stacked planar layers, said apparatus including:

a stitch head mounted at a fixed location and actuatable to insert a stitch through a stack of two or more planar layers located beneath said stitch head;

a substantially horizontally oriented bed for supporting said stack of planar layers for manually guided movement across said bed beneath said stitch head;

detector means for detecting movement of a surface of said stack oriented parallel to said bed and proximate to said stitch head for producing signals representing the magnitude of stack surface movement; and

control circuit means responsive to said signals indicating stack surface movement exceeding a certain threshold for actuating said stitch head to insert a stitch through said stack.

2. The apparatus of claim **1** wherein said stitch head includes a needle mounted for reciprocal movement substantially perpendicular to said bed between a full up position and a full down position; and wherein

said control circuit means for actuating said stitch head includes means for applying power to said stitch head to cause said needle to traverse one cycle from said full up position to said full down position to said full up position.

3. The apparatus of claim **2** wherein said means for applying power includes a motor/brake assembly operable in a motor mode for moving said needle and a brake mode for stopping movement of said needle.

4. The apparatus of claim **2** wherein said means for applying power includes a motor and a clutch/brake assembly; and wherein

said clutch/brake assembly is operable in a clutch mode for coupling said motor to said stitch head for moving said needle and a brake mode to stop movement of said needle.

5. The apparatus of claim **1** wherein said bed defines a flat substantially horizontal surface for supporting said stack of planar layers; and wherein

said stitch head includes a needle mounted for movement substantially perpendicular to said bed surface between a full up position and a full down position whereat it pierces said planar layers supported on said bed surface.

6. The apparatus of claim **5** wherein said control circuit means for actuating said head includes means for selectively applying power to said stitch head to cause said needle to move from said full up position to said full down position.

7. The apparatus of claim **6** further including means for returning said needle from said full down position to said full up position.

8. The apparatus of claim **1** wherein said detector means includes a light source for illuminating said stack surface; and

means for processing light reflected from said illuminated stack surface for determining the magnitude of movement of said stack surface.

9. The apparatus of claim **1** wherein said detector means includes optical means for measuring movement of said stack surface along orthogonal X and Y axes; and

signal processing means responsive to said measured movement for determining the magnitude of resultant movement of said stack; and wherein

said control circuit means actuates said stitch head when the magnitude of said resultant movement exceeds a predetermined stitch length.

10. A machine for stitching at least one fabric layer, said machine comprising:

an upper arm and a lower arm mounted in vertically spaced substantially parallel relationship to define a throat space therebetween;

a substantially horizontally oriented plate on said lower arm for supporting said fabric layer for guided movement in said throat space;

a needle arm supported from said upper arm above said plate actuatable to insert a stitch into said fabric layer;

a detector for detecting movement of a surface of said fabric layer oriented parallel to said plate and in said throat space; and

control circuitry responsive to detected movement of said fabric layer surface for controlling actuation of said needle arm.

11. The machine of claim **10** wherein said detector operates to produce X and Y signals respectively representing the magnitude of translational movement of said fabric layer surface along perpendicular X and Y axes.

12. The machine of claim **10** wherein said detector operates to detect movement of said fabric layer surface without physically contacting said fabric layer.

13. The machine of claim **10** wherein said detector includes:

a window oriented to collect energy from said fabric layer surface oriented parallel to said plate; and

signal processing means responsive to energy collected by said window for producing signals representing the magnitude of movement of said fabric layer across said plate.

14. The machine of claim **13** wherein said detector includes a source of energy for illuminating said fabric layer surface to reflect energy into said window.

15. The machine of claim **14** wherein said source of energy comprises a light source and said window collects light images reflected from said fabric layer surface.

16. The machine of claim **13** wherein said produced signals represent translational movement of said fabric layer surface along perpendicular X and Y axes.

17. The machine of claim **10** wherein said needle arm includes a needle mounted for cyclic movement between an up position spaced from said plate and a down position piercing said fabric layer proximate to said plate; and wherein

said control circuitry is actuatable for moving said needle through at least one cycle comprising needle motion from said up position to said down position to said up position.

18. The machine of claim **17** wherein said control circuitry includes a needle drive means for moving said needle through a cyclic movement in response to a certain magnitude of fabric layer movement detected by said detector.

19. The machine of claim **18** further including user means for adjusting the value of said certain magnitude.

20. The machine of claim **17** wherein said control circuitry includes a needle drive means for repeatedly cyclically moving said needle at a rate related to the speed of fabric layer surface movement detected by said detector.

21. A quilting apparatus for inserting stitches of uniform length through a stack of one or more fabric layers, said apparatus comprising:

a stitch head;

a bed defining a substantially horizontally oriented planar surface mounted opposite to said stitch head, said planar surface being configured to support said stack for guided movement across said planar surface;

said stitch head including a needle operable to execute a cyclic movement from an up position remote from said planar surface to a down position piercing said stack on said planar surface, and back to said up position;

a detector defining a window for collecting energy from a target area substantially coincident with a surface of said stack oriented parallel to said planar surface;

signal processing means responsive to said collected energy for indicating the magnitude of stack translational movement across said planar surface; and

control means responsive to a translational movement of said stack of a magnitude exceeding a certain threshold for causing said needle to execute said cyclic movement.

22. The quilting apparatus of claim **21** wherein said detector includes:

a light source mounted to illuminate said stack surface in said target area; and wherein

said window is oriented to collect light images reflected from said target area.

23. A method of forming successive stitches of uniform length through a stack of fabric layers having top and bottom surfaces, said method comprising:

mounting an actuatable stitch head at a fixed location;

manually moving said stack of fabric layers across a horizontal planar surface under said stitch head;

detecting the movement of at least one of said stack surfaces oriented parallel to said horizontal planar surface proximate to said stitch head; and

actuating said stitch head in response to a certain magnitude of detected stack movement to insert a stitch through said stack of fabric layers.

24. The method of claim **23** wherein said step of mounting said stitch head includes mounting a needle for cyclic vertical movement between an up position spaced from said stack and a down position penetrating said stack moving across said planar surface.

25. The method of claim **23** wherein said step of detecting the movement of said stack includes:

providing an energy source for illuminating a target area of a surface of said stack;

collecting energy images reflected from said target area; and

processing said collected energy images to determine the magnitude of movement of said stack.

26. The method of claim **23** wherein said step of actuating said stitch head includes moving said needle through a single cyclic movement in response to each increment of stack movement greater than said certain magnitude.

27. The method of claim **23** wherein said step of actuating said stitch head includes repeatedly cyclically moving said needle at a rate related to the speed of stack movement.

28. A method of forming successive stitches of uniform length through a stack of one or more fabric layers having top and bottom surfaces, said method comprising:

providing a horizontally oriented planar surface for supporting said stack for guided movement across said planar surface;

mounting a stitch head opposite to said planar surface where said stitch head is selectively actuatable to insert a stitch through said stack layers;

manually moving said stack across said planar surface;

optically observing a target area coincident with one of said stack surfaces oriented parallel to said planar surface to determine the magnitude of stack movement proximate to said planar surface; and

responding to a magnitude of movement greater than a certain threshold for actuating said stitch head to insert a stitch into said stack.

29. The method of claim **28** wherein said step of moving said stack comprises a user manually grasping said fabric layers to push/pull said stack across said planar surface.

30. The method of claim **28** wherein said stack is mounted on a frame; and wherein

said step of moving said stack comprises a user manually grasping said frame to push/pull said stack across said planar surface.

31. A quilting apparatus for inserting stitches into a stack of one or more fabric layers, said apparatus comprising:

a stitch head;

a bed defining a substantially horizontally oriented planar surface mounted opposite to said stitch head, said planar surface being configured to support said stack for guided movement of said stack across said planar surface;

said stitch head including a needle operable to insert a stitch into said stack by executing a cyclic movement including a needle-up position remote from said planar surface and a needle-down position piercing said stack proximate to said planar surface;

a detector for measuring the movement of said stack across said planar surface proximate to said stitch head; and

control means for causing said needle to execute cyclic movements at a rate substantially proportional to the rate of stack movement measured by said detector.

32. The apparatus of claim **31** wherein said detector operates to measure the magnitude of translational movement of said stack along orthogonal directions.

33. The apparatus of claim **32** wherein said control means causes said needle to execute one cyclic movement for each threshold unit of movement measured by said detector.

34. The apparatus of claim **31** wherein said stack of fabric layers includes an exterior stack surface; and wherein

said detector measures stack movement by measuring translational movement of said exterior stack surface.

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